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JAMES H. McKENNEY,
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THE STATE OF GEORGIA, BY ITS ATTORNEY-GENERAL, JOHN C. HART, PLAINTIFF,

vs.

THE TENNESSEE COPPER COMPANY AND THE DUCKTOWN SULPHUR, COPPER AND IRON COMPANY (Limited), DEFENDANTS.

IN EQUITY.

MEMORANDUM OF ARGUMENT FOR COMPLAINANT UPON FINAL HEARING.

JOHN C. HART,
Attorney-General of Georgia.

LIGON JOHNSON,
Solicitor for Complainant,
ATLANTA, GA

The Franklin-Turner Company, Atlanta, Ga.

STATEMENT.

The cause of action in this case arises from injuries done and threatened the commonwealth of Georgia, its domain, highways, streams, water supply and atmosphere and to the property, health and welfare of its citizens and the comfortable enjoyment by them of their homes and possessions, and also by reason of the threatened pauperization of whole communities and the practical annihilation of the means of sustenance and livelihood of the inhabitants thereof, making such inhabitants charges or liable to become charges upon the State. These damages and conditions are occasioned by the unlimited generation and continuous and unrestricted liberation of sulphur dioxid and other noxious fumes by the defendants through the operation of the copper smelting and reduction plants in the State of Tennessee and but a short distance from the Georgia line.

The destructive fumes and gases have been produced in the Ducktown region in quantities sufficient to injure Georgia and her citizens but a short time. The injuries in Georgia have been accomplished within the past five years, the damage each year more than doubling that of the year preceding. During the last spring and summer, since the installation of the high stack by the Tennessee Copper Company, the increase has amounted to about six times the total damage theretofore wrought by the defendants.

While copper was mined in the Ducktown region prior to the operations of the defendants herein, it was of a wholly different character of ore, known as "Black Copper" or oxide of copper, an ore frequently found upon the surface and often shipped in the state picked up or mined. This ore was very high in copper, and had little or no sulphur contents and, when roasted or smelted, produced practically no sulphur dioxid. The black copper ore was exhausted in the early

seventies and all copper operations were abandoned, notwithstanding the fact that the property owners were aware of the existence of the sulpurous ore now mined, as the percentage of sulphur in such ore was so enormously high as to cause it to be deemed worthless.

From about 1875 up to 1900 little or no copper was produced in the Ducktown region or in the Southern States. The gross production of copper through the entire South for the five years beginning 1885 was approximately but 125,000 pounds, about the daily capacity of defendants'. Copper operations in the Ducktown region, since the days of "black copper" have been practically confined to the defendant companies.

The defendant, the Ducktown Copper Company, began experimenting with the low grade copper ores in the early nineties, but it was not until 1900 that any appreciable amount of copper was produced and until that year the operations of the Ducktown company were on so small a scale (it being located about three miles from the nearest Georgia territory) that the effects of its fumes were not perceptible as far distant from the plant as the Georgia line. The Tennessee Copper Company began smelting to a limited extent the latter part of 1901, but it was not until the spring of 1902 that anything like extensive operations were begun. With the beginning of the Tennessee Company's operation and the increased production of the Ducktown Company the deadly effect of the sulphur dioxid began to show on Georgia soil.

The spread of the damage by the sulphur fumes was so rapid that the citizens of the counties adjoining the Tennessee line became alarmed and in 1903 petitioned the Legislature of the State of Georgia for protection. In consequence of this petition a legislative committee was appointed to make an investigation and report in the premises, and, in the event the investigation should disclose the injuries declared by the petition, the Governor of Georgia was authorized to take any necessary steps to secure an abatement of the nuisance.

Immediately upon their appointment, the members of the committee visited the territory adjacent to the mining region and, after a full investigation, made formal report that considerable damage had already been wrought in Georgia by the fumes from the copper plants and recommended immediate steps to secure relief therefrom.

This report and recommendation thereon were communicated by Georgia to the Governor of Tennessee, with the request that Tennessee abate such nuisance and prevent further injury to Georgia and her citizens by Tennessee, her citizens and denizens, which request Tennessee not only declined to grant but further declined to aid Georgia in the premises or to in any manner seek to remedy the injuries and evils reported, Tennessee suggesting that Georgia should look to the proper courts for any relief which she might seek or claim.

Upon receipt of such refusal, the State of Georgia, after first notifying the copper companies to desist in the commission of said nuisance and damage, which said copper companies refused to do, filed its bill to the October term, 1903, of this Honorable Court, seeking the abatement of said nuisance and an injunction against the liberation of the harmful gases produced by the defendant companies.

At the time the first bill was filed the defendant companies freed the ore of its sulphur contents by the open roast pile or heap method, being mounds of ore which, when once ignited, continued to burn until the sulphur was exhausted, in the manner of the ordinary sulphur candle. These roast yards were located adjacent to the several mines of the defendants, some yards containing as much as thirty acres of heaps. The defendant, the Tennessee Copper Company, had three yards, two being at mines a little over three miles from the Georgia line and one about a mile nearer. The yard of the Ducktown Company was something over three miles from the State line.

After about three months incineration in order to liberate the sulphur from the ore mass, the remaining product with its iron slag and other contents was taken to the smelters for

smelting, and refining and moulding into ingots or other convenient form for transportation and the market. The smelters of the Tennessee Company were located at McCay's, but a few hundred yards from the Georgia line; those of the Ducktown Company at a point equally or perhaps slightly more remote than its roast yards.

While the first bill in this connection was pending it was represented by the copper companies and believed by the companies and the State of Georgia that the nuisance complained of was due to the mode of roasting ore then in use and that a different process might be adopted whereby the matter might be remedied. The existing mode of operations the defendants proposed to forever abandon and by so doing to eliminate the nuisance provided Georgia would dismiss her suit, which proposition was accepted and the first bill in this connection dismissed.

Shortly after the dismissal of the first bill the Tennessee Copper Company, the chief offender by reason of its larger production and the present location of its plant, abandoned its roast yards and removed its roasting appliances to its smelting furnaces, at McKay's, Tennessee, where its roasting operations are now conducted, within but a hundred yards or so of the Georgia line, and began producing the sulphur dioxid in much stronger form and liberating and diffusing same directly upon Georgia soil without even the leavening influence of the several miles of atmosphere which formerly intervened. In addition, The Tennessee Copper Company, during the pendency of the present bill, has installed further roasting appliances and furnaces more than doubling the capacity of the plant over that possible when the first or present bill herein was filed.

The remaining defendant, the Ducktown Sulphur, Copper & Iron Company, is still producing said fumes at a point about equally distant and to about the same extent as when the first suit was brought.

The production of sulphur dioxid by both companies under the new process, its liberation in concentrated form,

and the change of location of the Tennessee Company's roasting plant resulted in vastly increased injuries in Georgia, not only as to the amount of property injured, but also as to the scope of territory damaged and number of citizens affected.

In consequence of the constant and increased damage, instead of complete relief from the nuisance as was expected, renewed and continued complaints and appeals for aid were received by the legislature from said locality, as well as general reports of injury by the officials of the State, and, by resolution approved August 15th, 1905, a committee of experts, including the State Chemist, Geologist and Commissioner of Agriculture, was provided for, said resolution directing an examination of the territory and the ascertainment of the damage, if any, being occasioned by said fumes, and further directing the Attorney-General, in the event of injury by said fumes, to take all proper and necessary means to prevent further injury within the State.

This committee reported the injuries vastly increased over those found by the committee of 1903 (the State Chemist and Geologist having been members thereof); that the amount of injury and scope of territory damaged was rapidly multiplying and infinitely greater damage threatened than had already been accomplished, and recommended immediate legal steps by the State to secure relief from the baneful effects of the fumes.

The results of this investigation were communicated to the defendants, who were again notified to abate said nuisance and to cease liberating into the atmosphere the sulphur dioxid generated by them. Notwithstanding the fact that the Bureau of Chemistry of the United States and technical mining journals had theretofore pointed out and even the President of the Tennessee Copper Company had confessed and declared that by installing sulphuric acid plants injuries by sulphur dioxid could be abated and a commercially valuable product produced, the defendants declined to take any steps whatever to condense or take care of their fumes or in

any manner to seek to remedy the nuisance, preferring to continue to produce copper to the capacity of the plants, while copper remained at its record price, and thereupon this bill was filed.

The nuisance affects five hitherto exceedingly prosperous counties of the State of Georgia, their chief occupations and industries being in farming pursuits and lumbering. The fumes now reach the country within a radius of about fifty miles from the nearest point on the Georgia line, involving a territory considerably exceeding a thousand square miles in extent. Vast quantities of farming lands within said area have already been abandoned or permitted to become wild land since the defendants began extensive operations.

During the pendency of this litigation and shortly prior to the hearing herein upon demurrer and application for temporary restraining order, the Tennessee Copper Company completed a taller and larger stack than that in use at the date the bill herein was filed. This stack was necessary to produce the draft essential to the operation of the plant when the new furnace, completed during the pendency of this cause, were blown in and the plant operated at its increased capacity. It was claimed by the Tennessee Company that the operation of this stack would completely remedy all injury on its behalf, and the cause was held over until the October term, 1906, with permission to produce additional testimony, which was done.

Upon November 5, 1906, this Honorable Court overruled the demurrers and application for temporary restraining order herein, directing answer and replication be filed by November 19th, 1906, and that the evidence be closed within sixty days from the date of such filing, the affidavits and exhibits previously introduced being permitted used as evidence at the final hearing. Upon filing answers and replications herein complainant and defendents agreed to produce no further testimony in the cause, to close the evidence and submit the cause upon the affidavits and exhibits previously produced and such governmental or U. S. Departmental reports or bulletins as might be referred to and submitted for the hearing.

The following is the evidence submitted for complainant:

1. Letter of the Tennessee Copper Company, joined in by the Ducktown Sulphur, Copper and Iron Company, relative to the abatement of the smoke nuisance under the proposed new process, seeking dismissal of original bill.

2. Agreement for abandonment of old process and of dismissal of original cause 14, 1903 term, in this Honorable Court in consideration thereof.

3. Affidavit of J. C. Haywood, Chief of the Miscellaneous Laboratory, Bureau of Chemistry of the United States, heretofore directed by the United States Department of Agriculture to investigate the effects of the fumes from the Ducktown copper companies upon vegetation, setting forth the result of such investigation and the chemical effects of said fumes.

4. Affidavit of J. K. Haywood setting forth the result of a second investigation made by him in September, 1906, after several months operation of the new stack and furnaces of the Tennessee Copper Company.

5. Bulletin 89, Bureau of Chemistry of the United States, in relation to the destruction of vegetation by sulphur dioxid produced at copper plants and showing that relief might be had by condensing the fumes and converting same into sulphuric acid. (November 15th, 1904.)

6. Affidavit of John M. McCandless, State Chemist for Georgia, as to the chemical effects of the Ducktown fumes and the conditions resulting therefrom.

7. Affidavit of W. F. Fiske, Entomolagist and Special Field Agent of the Bureau of Entomology of the United States, detailed by said bureau to determine the relation of sulphur dioxid in the smoke of said copper companies to the injury by insects in the forest killed or in course of destruction in the Ducktown vicinity, showing the destruction of vegetation not due to insects or disease.

8. Affidavit of Ralph I. Smith, Entomologist to the State of Georgia, setting forth his investigation of the destruction of vegetation in the Ducktown locality and the fact that said destruction was not due to insect injuries.

9. Second affidavit of R. I. Smith, setting forth the result of an investigation in the fall of 1906, after several months operation of the tall chimney and new furnaces of the Tennessee Copper Company.

10. Affidavit of Wilmon Newell, Entomologist of the State of Louisiana, showing conditions in said Ducktown locality in the year 1903, and the fact that at such time no destructive insects were present in the timber of said section, but that same was then being injured and destroyed by causes other than insects or disease.

11. Affidavit of J. S. Holmes, Forester and Forest Assistant to the Bureau of Forestry of the United States, commissioned by said bureau to investigate for the United States Government the forest conditions in and around the Ducktown vicinity, showing the destruction of forests in such locality to be due to the sulphur fumes and not to insects or plant diseases.

12. Affidavit of U. S. Forester A. B. Patterson, detailed by the United States at the request of the State of Georgia, to make an investigation of the Ducktown region during the fall of 1906, after several months operation by the Tennessee Copper Company of its new stack and furnaces, embodying the result of his investigation, and showing the sulphur dioxid injuries to have increased about 600 per cent. above those found by Forester Holmes in 1905, attaching blue prints to the map of the Department of Forestry of the injuries in 1905.

13. Affidavit of D. A. Jones, E. Buffington, L. D. Rogers, A. E. Sharp and M. T. Mauney, foresters, as to forest conditions in Murray, Gilmer, Fannin and Union counties and showing the destruction of the forests by the fumes generated by said copper companies and damage already done to the timber.

14. Second report of the Commission appointed by the State of Georgia of investigation in the fall of 1906, showing increase of injuries over those found in 1905.

15. Affidavit of State Forester Chas. A. Keffer of Tennessee embodying the condition of the territory as found by him in the autumn of 1906.

16. Affidavits of Frank E. Shippen and A. E. Sharp, showing that the lumber interests within Murray, Gilmer, Fannin, Union and Towns counties will be destroyed by the continuance of said fumes, and that hundreds of men and teams will be thrown out of their employment and means of livelihood thereby, that thousands of dollars of property have already been destroyed and many hundreds of thousands more injured and will be destroyed if the fumes continue.

17. Duplicate original map of the Department of Forestry of the United States showing the value and condition of the forests generally in the counties affected, and that such forests were above the average of the Appalachian forests.

18. Bulletin 7, United States Department of Agriculture, Forestry Division (by B. E. Farrow); bulletin 62, United States Geological Survey and bulletin 80, United States Geological Survey "Water Supply and Irrigation Papers," relating to Southern Appalachians and embracing the Ducktown region, and Farmers Bulletin No. 20 United States Department of Agriculture "Washed Soil," relative to failure of water supply, destruction of soil fertility and soil erosion occasion by the removal of forests from the mountains and mountainous sections.

19. Senate Document 54, Fifty-Seventh Congress, first session, being a joint report by the Bureau of Forestry and United States Geological Survey, under special appropriation therefor and after two years investigation of the Appalachian forests, soils, water supply and conditions, setting forth the erosions of soils upon the destruction of forests, the utter failure of mountain lands as pasture and that ample experiments had developed that even the planting of selected grasses would not prevent the washing of the soil and the destruction of the fertility not only of the hillsides but of the outlying valleys and in the end the utter ruin of the fertility of the region. The report further set forth the necessity of the preservation of the forests for the protection of both the volume and purity of the water supply originating within the region.

20. Affidavit of W. S. Yeates, Geologist for the State of Georgia, showing the geological results from the destruction of forests in North Georgia.

21. Affidavit of Wm. A. Wright, Comptroller of the State of Georgia, showing the abandonment in the past two years of 43,391 acres of improved lands in the counties of Fannin, Murray and Union, said land being no longer cultivated, but allowed to lapse into barren or wild state; and the increase of cultivated lands in the counties adjoining Murray, Fannin and Union; and affidavit of T. G. Hudson, Commissioner of Agriculture of Georgia, showing the enormous increase in value of farm lands within the State.

22. Second affidavit of Wm. A. Wright, showing the abandonment of the enormous amount of 86,415 acres of land in the affected territory during the fiscal year of 1905–6; and the decrease in tax values in the affected zone.

23. Declarations of the Tennessee and Ducktown Copper Companies as made to and compiled by the United States Geological Survey, and general copper facts and statistics as contained in the bulletin "Copper" of the United States Geological Survey Report "Mineral Resources of the United States" for the years 1901, 1902, 1903, 1904 and 1905.

24. Reduced reproduction of and quadrangles of the United States Geological Survey for Ellijay and Murphy sections, being maps of the Ducktown region showing the locations of the several mines of the defendants, adjoining which the roast yards were located during the operation of the open heap method.

25. Simons' Manual of Chemistry defining and describing sulphur dioxid.

26. Engineering and Mining Journal for July, 1904, and volume "Pyrite Smelting" containing a statement by defendants of the profits under the present method over those of heap roasting and the declaration of J. Parke Channing, President of the defendant the Tennessee Copper Company, of the monthly consumption of ore per furnace; that the sulphur dioxid generated was of great strength and could be

converted into sulphuric acid; that by such condensation injuries by the copper plants would practically be eliminated and that a tall stack, such as was subsequently built, was necessary to afford proper draught to operate the plant when the new furnaces to be built were blown in. And also the summary by the mining and smelting expert for the engineering and mining Journal setting forth the power of copper plants to condense their fumes into sulphuric acid and estimating the profit and loss of the operation of an acid plant in conjunction with copper production.

27. New International Encyclopedia (volume xvi. page 225, 226) specifying uses of sulphuric acid.

28. Bulletin 210 of the Department of Census of the United States upon "Chemicals and Allied Products" setting forth the sulphuric acid contents of other acids and the partial consumption of sulphuric acid in the manufacture of other acids in the United States during the year 1901.

29. Tabulation of the Department of Census of the United States showing the sulphuric acid used in explosives.

30. Affidavits of R. F. Sams, D. B. Osborne and H. A. Rogers, extensive manufacturers of fertilizers, specifying the sulphuric acid contents of fertilizers, and declaring the phosphate rock of the United States to be utterly valueless except in conjunction with equal or greater weight of sulphuric acid.

31. Bulletin of the Geological Survey of the United States "Production of Phosphate Rock" for 1905 showing the States of Tennessee, South Carolina and Florida alone to produce phosphate rock to an amount requiring sulphuric acid in double the gross possible production at present capacity by defendants.

32. *American Fertilizer Magazine*, the official organ of the Fertilizer Manufacturers' Association, giving table of fertilizer consumed in six States adjoining Tennessee in 1905.

33. Certificate of the department of census as to fertilizer manufacturers in the States therein enumerated.

34. Affidavit of A. A. Smith, broker in sulphuric acid and fertilizer supplies, showing the market price of sulphuric acid, f. o. b., Atlanta, Ga., to be $10.40 per ton.

35. Affidavit of John M. McCandless, chemist, specifying the gross possible production of sulphuric acid by the defendants under maximum operation of their present plants.

36. Affidavits of fifteen hundred inhabitants of said region showing the injury to public roads and destruction, up to the winter of 1905, of crops, orchards, timber and gardens, and the utter ruin of hundreds of square miles of farming, lumbering and fertile territory by the fumes of the Ducktown works; that the damage was rapidly increasing, and the fact that a continuance of said fumes will render valueless hundreds of thousands of dollars' worth of property and in effect work a confiscation of a large area of territory within the State of Georgia, pauperizing many communities as well as individuals.

37. Affidavits of more than two thousand citizens of the State of Georgia of the great and vastly increased damages during the spring, summer and autumn of 1906, since the installation of the new furnaces of the Tennessee Copper Company and the operation of the new stack. Also several hundred affidavits reciting the utter destruction of gardens, crops and even hillsides of timber by a single visitation of the fumes in their present condensed form.

Testimony of Health Officer, Dr. S. B. Graham, and numerous affidavits showing severe typhoid epidemics since the destruction of the timber and falling of the leaves in the early summer and other harmful effects of the said fumes upon the health of the inhabitants of northern Georgia.

38. Photographic views of said region, showing forest destruction, soil erosion, injuries to the highways and the like, and the affidavits of Smith, Edwards, Fields, Jones, Patterson and others identifying said pictures and specifying said views as exhibits.

39. Affidavits of W. J. Witt, J. J. Cordell, W. J. Witt, Sherman Martin, C. C. Andrews, J. A. Tipton, A. S. Jones

and others, former or present foremen or employees of defendents or residents of the vicinity of the copper works, identifying a considerable majority of the witnesses produced by the defendant as employees and dependents of defendants and not *boni fide* citizens of Georgia and declaring that the employees of the Tennessee Copper Company were given holidays with regular pay to come to Georgia and hold mass-meetings in the effort to create sentiment in Georgia against the suit herein, said employees being threatened with loss of occupation should Georgia succeed in maintaining her bill against the liberation of defendants' gases.

40. Affidavits of S. Y. Garrett, D. A. Jones, W. A. Davis and D. A. Jones showing that about four-fifths of the witnesses for defendants claiming to be citizens of Georgia and of the attendants of an alleged massmeeting of protest against this suit, neither pay taxes upon any property within the State, nor do they appear upon the tax records of the several counties, and, consequently, are neither registered citizens nor voters within the State of Georgia.

The defendants have produced about six hundred witnesses, a majority of whom have been directly identified as employees and dependents of the defendants, witnesses threatened by defendants with a loss of occupation if the relief herein sought be granted, who are neither property owners, tax payers, voters or registered as citizens within the State of Georgia, and of which witnesses but twenty-five made affidavit within the confines of the State. These witnesses in general terms deny the allegations of complainant's bill and also declare that the new stack (at the time of such declaration but barely completed) would prove a panacea for the damages which had neither occurred nor were threatened.

About a hundred affidavits, taken after several months operation of the new stack and furnaces are also in evidence. These witnesses declare conditions in Tennessee, in the immediate vicinity of the plants, to have improved since the

operation of the high stack, a result expected and predicted by Georgia's experts and counsel. Not a denial (except by counsel) of the injuries alleged is made, or that the general zone of injury had increased. Each of these affidavits is taken in Polk county, Tennessee, where the plants of the defendants are located and of these witnesses a large per cent. had previously been identified as employees of defendants. There are also a dozen or more of affidavits from witnesses who had theretofore testified as to the injury alleged by Georgia, who state that they desire to have the defendants condense or take care of their fumes and not have their plants closed.

In addition the defendants have produced five foresters, as experts, who by affidavits make a "general argument in refutation" of the bill, and who advance several theories as to the cause of the forest destruction in the Ducktown region.

ARGUMENT.

This cause involves two questions: first of law, the right of the court to hear the case, and second of fact, whether the injuries and damages complained of have been and are being sustained by the complainant. The court having heretofore overruled the demurrer to the jurisdiction it will be assumed that the question of law has been settled and the law involved will not here be considered beyond a reference to the law brief previously filed. The question of fact, the truth of the allegations of injury and damage, it will be the purpose of this argument, in the light of the record herein, to demonstrate.

THE GENERAL INJURY.

That there has been within the past five or six years great destruction of forest and vegetation in the Georgia counties of Fannin, Gilmer, Murray, Union and Towns not even the defendants deny. Vast quantities of timber have been destroyed throughout over a thousand square miles of territory in what may be termed the Ducktown region, crops have been killed, gardens ruined, orchards devastated and a large area converted from a reasonably prosperous community into well-nigh a desert waste. Mile upon mile of territory has been not only wholly denuded of vegetation but so eroded that only the subsoil of decaying rocks with here and there a patch of top soil capable of sustaining vegetable life remains. This is shown beyond dispute by the pictures filed as exhibits to the testimony of R. I. Smith, by pictures from U. S. Bureau of Forestry and even those filed by the defendant, the Tennessee Copper Company, with defendant's original volume of testimony, final pages, as exhibits A, B and C. Roads have been

gullied, blocked and made impassable and outlying valley farms washed, covered with debris and rendered unfertile.

Throughout all this region and in localities adjacent thereto Georgia's citizens and inhabitants are largely farmers and dependent upon the products of the soil for their sustenance and livelihood.

The fumes affect a territory in the very center of the watershed, of the headwaters of Georgia's streams and in the southern center of the region which the Federal Administration and the surrounding States so strongly urge set aside as a national forest reserve in order that the water supply of the Southern States may be protected. Within this region is the heaviest rainfall in America, with the single exception of a limited area along the northern Pacific Slope, and through these rains and from these mountain forests the streams of the South find their source.

The topography of the region is such that, in addition to the influence of the prevailing winds toward Georgia, the fumes must find an outlet mainly to the south. As expressed by Forester C. A. Schenk, a witness for the defendants, the copper plants are in a "horn shaped" bowl in the mountains the point of the horn being in Tennessee. The depression is V-shaped rather than like a horn and widens rapidly as it progresses into the Georgia plateau, as is shown by maps (Plates IV and XII) of the Government Bulletin, "The Southern Appalachian Region," filed herein. The result is that the high mountains in Tennessee block the fumes to the immediate north, east and west, leaving the only outlet and forcing the wind currents to the southward, where no sufficient barriers exist to obstruct the fumes or change their course from Georgia soil, and in which region the living vegetation must largely act as a buffer to further progress of the sulphur dioxid, for the fumes drift further and further as each successive area is denuded of forest and vegetation.

The destruction of vegetation within this region has been so heavy and the injuries so marked that prior to the institution

of this cause they were subject to investigation not only by the experts in Georgia's employ but also by the United States through its Bureau of Forestry, Department of Chemistry and Bureau of Entomology.

EXPERT TESTIMONY.

Other than her Chemist, Entomologist and Geologist, whom the State sent to Northern Georgia to make an examination of conditions there and subsequently directed to embody the result of such investigations in affidavits for use herein, the complainant has sent no experts to visit the region in order to supply expert testimony towards sustaining her contentions in this cause. Some time after the bill herein was filed it was learned that the United States had caused investigations of said region by its Bureaus of Forestry, Chemistry and Entomology, such investigations being made before the institution of this suit and wholly without solicitation by or even knowledge of complainant, and a request was made to the Honorable Secretary of Agriculture that he direct the officials of said Bureaus making such investigations to furnish affidavits for use herein setting forth the results thereof. These affidavits (the first of the expert series) were so furnished and filed. The affidavits by other foresters and experts were based upon investigations made by them in connection with their duties or professions and without the instance of the State of Georgia.

The second series of affidavits by the United States Forester and Chemist were based upon a second investigation by the Bureaus of Forestry and Chemistry after several months' operation by the Tennessee Copper Company of its new furnaces and tall stack. This second examination was requested by the State of Georgia in order that an impartial investigation might be had by competent and wholly disinterested experts and the true facts known. Georgia further requested that the results

of these investigations, regardless of what same might disclose, be embodied in affidavits to be filed in this cause, the complainant viewing these experts more in the light of arbitrators than as expert witnesses for complainant.

The testimony of all of these witnesses (Complainants' Record, pages 5 to 63) bear out the allegations of complainants' bill both as to the destruction wrought and the cause of such destruction.

CHEMICAL EFFECTS OF THE FUMES.

It is a matter of common knowledge that sulphur dioxid is deadly to vegetation. Every chemical plant making use of this gas demonstrates its destructive qualities and each copper mining district where the ore is high in sulphur and is incinerated without provision being made for condensation of or protection against the attendant fumes becomes an eloquent witness of the fact that sulphur dioxid can and does convert a region subject to its effects into a barren waste.

These effects were long ago declared and demonstrated by chemists of both Europe and America. Prior to the institution of this suit the result of fumes arising from a copper plant utilizing similar ores were investigated by the United States Bureau of Chemistry, the result being published in Bulletin 89 of the Department of Agriculture. (Complainant's Record pages 13 to 17.) Through this investigation and by said bulletin it is shown that sulphur dioxid of the strength of one part to 100,000 of air is deadly and one to 1,000,000 is injurious. At the strength of one to 10,000 the injury is immediate and the death of the plant is quickly accomplished.

These facts are further certified to by J. K. Haywood, Chief of the Miscellaneous Laboratory, United States Bureau of Chemistry (Complainant's Record, page 5 et seq.), who has had considerable experience with sulphur fumes and made exhaustive investigations and much original research into their

influences and effects, and by John M. McCandless, Chemist for the State of Georgia (Complainant's Record, page 18), who has also made extensive study of the matter. Both of these experts have made a personal examination of the Ducktown region and the destruction of plant life therein, one at the instance of the Federal Government and the other under direction of the State of Georgia. Both testify most positively that the destruction of vegetation throughout the territory is due to the sulphurous gases produced and liberated by the defendants.

The sulphur fumes generated by the defendants and liberated from their chimneys are shown, and by officials of defendants admitted, to be in excess of 6 per cent. in strength, so that the gas might expand six million times after its liberation and still be injurious to vegetation.

Sulphur dioxid is two and one-half times heavier than the air, and is carried through the stacks of the defendant companies only by the heat expansion and draught of the chimneys. It is a cohesive gas, and diffuses slowly. In the heated and expanded state discharged from the chimneys it tends to contract from the cooling effect of the air and fall to the earth rather than to spread out and diffuse, and when it has once fallen it rolls along the earth in front of the wind until some obstruction blocks its way and, in effect, dams it up, or until it is absorbed by the living vegetation. The fumes may, and often do, settle upon the earth several miles from the plant in almost the full strength discharged from the chimneys, and, when held by hilly or mountainous barriers or forest obstruction, spread and expand only as new supplies of fumes make a larger reservoir necessary, in the manner of backwater from a newly erected dam. Under such conditions, not a few days or a few hours, but a very few minutes are required to wilt and wither and in the end destroy every vestige of vegetation. The terrific possibilities for destruction and vast area of possible injury is clearly pointed out by chemists Haywood and McCandless.

In addition to the expert testimony produced, the destructive qualities of the fumes are further declared by about four thousand lay witnesses, who testify to the utter annihilation of vegetation when subjected to the sulphur dioxid of the defendants and to the heavy destruction within the vicinities of their domiciles within the past six years, since the sulphur fumes first made their appearance. The testimony of these witnesses, however, will be discussed in a separate paragraph.

Against this overwhelming and positive testimony of the damage by sulphur fumes defendants interpose the single affidavit of B. E. Fernow, a forester, who neither qualifies as a chemist nor even claims a knowledge of chemistry. And the strongest testimony this witness can give is: "All I have seen at the distant points are single dead trees or trees with dead or damaged foliage, such as might exist from a number of causes. While I do not deny the possibility that the fumes may have been the cause, or a contributing cause, it would require very positive proof for me to accept such diagnosis." (Defendants' Original Record, page 155.)

"I have also observed conditions for many miles from the car windows, and from these observations conclude that the effect of the fumes is not followed by as dire consequences as represented in the bill, argument and exhibits." (Page 156.)

"To answer the question as to the probable damage, we must come to a conception of what takes place in the visible gas column, and we must also inquire into the question of the admissible limit of gas in the air, which in turn calls for a consideration of the manner in which the vegetation is damaged."

"Actual knowledge as to these questions is poorly developed, and we have to deal largely with theories." (Page 160.)

In the end the best the witness can do is to reach a theoretical conclusion that the gas ought not to do what it actually does do. We have supplied the positive proof and furnished actual knowledge gained from personal investigations and original research to take the place of vague theories. Even without this positive scientific proof the several hundred witnesses, who relate specific instances of the destruction of vegetation by a single visitation of the fumes, would alone establish the destructive effect of the gases beyond question.

NORTH GEORGIA FORESTS.

The forests of the southern Appalachians are, in many respects, without a peer throughout North America. "These are the heaviest and most beautiful hardwood forests of the continent. In them species of the East and West, North and South mingle in growth of unparalleled richness and variety. They contain many species of the first commercial value and furnish important supplies which can not be obtained from any other region."

"The slopes of the ridges in North Georgia are still largely forest covered, and along them are countless springs which, with notable consistency, feed the great rivers of that State and Alabama." (*U. S. Bulletins, "The Southern Appalachian Region"* and *"Water Supply and Irrigation Paper 62."* Complainant's Record, pages 90, 86, 87 and 83.)

About 90 per cent. of the Ducktown region and territory adjacent thereto is under forest cover. (Defendants' Original Record, pages 28, 170), the remaining ten per cent. being valley farms along streams radiating from, or by, mountain passes opening into the Ducktown basin. (Map, Plate XII, *"The Southern Appalachian Region."*)

But two small areas throughout the entire Appalachians have a higher grade or greater profusion of timber than Fannin county, Georgia, which immediately adjoins the copper plants, and the forests of the remaining counties are of great value and extent and easily fall within the average of value and importance of the general Appalachian forest. (Exhibit, Duplicate Original Forest Map, U. S. Bureau of Forestry.)

These were the forest conditions found throughout the Ducktown territory in 1903-4 and up to the heavy spread of fume injuries in 1906.

FUME EFFECTS UPON THE FORESTS.

(FORESTRY EXPERTS.)

The damaged forest and forest injury from the sulphurous fumes are classified by expert foresters into three general zones: First, the zone of absolute destruction and complete forest annihilation; second, the zone of severe and uniform injury, with heavy destruction; and third, the zone of general but not uniform injury, within which, the distance from the plant permitting, occasional localities protected by sufficient barriers are found as yet almost immune from fume effects, while more remote and unprotected territory shows considerable and general damage.

By the blue print map of the Bureau of Forestry, filed herein, and affidavit of U. S. Forester A. B. Patterson (Complainant's Record, page 42), the zones of injury in 1905 are shown as follows:

Zone one, of absolute destruction, covering the territory from three to five miles from defendants' plant; zone two, of severe and uniform injury, ranging from zone one to from six to thirteen miles from the copper works, and zone three, of general injury, extending from zone two to from seven to twenty miles from the source of the damage. These zones are duly platted upon the blue-print map of the Bureau of Forestry and are illustrated by pictures from the Forestry Bureau filed with picture exhibits and identified by A. B. Patterson under numbers 63032, 63036, 63038, 63039, 63040 and 63041. The forest injuries up to the winter of 1905 are also specified by Foresters Jones, Rodgers, Buffington and Sharpe (Complainant's Record, pages 47 to 64).

The only witness for the defendants who attempts to fix the zones of injury is Forester C. A. Schenk (Defendants' Original Record, page 168), who testifies only as to the zones as found by him in the summer of 1905, and who declares the zone of complete destruction to be three and one-half square

miles in Georgia, severe injury to extend for two and one-half miles from the Georgia line, and general injury to range over a territory extending eleven and one-half miles from the boundary line between the States. Forester Schenk fixes the injured territory of Georgia in 1905 at a little over one hundred and thirty square miles, as against total injuries of something over two hundred square miles as shown by blue-print map of Forestry Bureau and affidavits of U. S. foresters.

The only foresters and experts specifying the zones of increased injury in 1906, after the operation of the new furnaces and high stack of the Tennessee Copper Company, are U. S. Forester A. B. Patterson (Complainant's Record, page 41), and U. S. Chemist J. K. Haywood (Complainant's Record, page 9); Tennessee State Forester C. A. Keefer (Complainant's Record, page 66), and Forester M. L. Mauney (Complainant's Record, page 61). These witnesses show the enormous increase of the injury during the spring and summer of 1906, extending more than thirty miles from the Georgia line, and containing about six hundred per cent. more territory than the total area of injury up to the winter of the preceding year. Of the several zones of injury, that of absolute destruction showed the smallest increase, it having advanced only about a half-mile into the territory theretofore included in zone two. The second zone of severe and uniform injury had within one year not only covered, but overlapped, the third zone as found in 1905, and the third zone had extended so far and at the time of the examination was increasing with such rapidity that its outer limits could not be fixed, for the reason that before a sufficient examination could be made to locate the outer limits a considerable increase in the area of injury would be accomplished. (Affidavit of U. S. Forester A. B. Patterson, Complainant's Record, page 45.) The increase in area of injured territory amounted to more than 1,250 square miles.

The investigation of the forestry experts produced by complainant also disclosed that there was no abnormal destruction within the injured region from insect injuries or plant disease,

and that same were not apparent to any greater extent than would be found in the average healthy forest. In some localities, where the timber had been greatly weakened and was dying from the sulphur fumes, destructive insects had begun to breed, as such timber became in effect incubators for the insects, but up to the time of the examination the depredations of insects had not extended to any timber except that which had been so debilitated as to invite attack by and afford breeding grounds for the forest insects. In each instance of injury the trees plainly disclosed that no attack had been made upon the timber until it had become weakened and injured by the sulphur fumes.

RELATIVE INSECT INJURY.

(TESTIMONY OF ENTOMOLOGISTS.)

While the chemists and foresters fully declared the destructive effects of the sulphur dioxid and located as nearly as possible the forest injury therefrom, directly identifying the forest injury to be due to this cause alone, in order to obtain as complete expression as possible as to whether or not any insect or similar injury contributed to the general damage, complainant requested affidavits setting forth the result of the examinations of the region by U. S. Entomologist Fiske (Complainant's Record, page 24), and State Entomologist Newell, of Louisiana (Complainant's Record, page 35), who had previously made exhaustive investigations of insect conditions within the Ducktown region, and also sent its entomologist, Ralph I. Smith, to make a study thereof and file his testimony herein embodying the result of his examination (Complainant's Record, pages 27, 32). Each of these experts unequivocally declares that no insect injury is disclosed beyond that to be found in the average normal healthy forest, and that the few instances of abnormal presence of destructive insects in any part of the territory was found only in occasional patches of

timber which had been previously so injured and weakened as to invite attack and offer a breeding place for the insects. In no case had insect ravages extended to timber which had not been damaged and debilitated by the fumes.

This testimony would hardly seem necessary to establish the fact that insects were in nowise responsible for the general destruction. Crops, gardens, grass and even weeds along the roadside, vegetation wholly exempt from attack by forest insects, suffers equally with the forest, being destroyed even more speedily, for, after being subjected to the fumes, this form of vegetation is immediately killed, withering and wilting to the ground. Even that most enthusiastic expert of defendants, Forester Howe, who, in one breath, declares the mortality of the white pine, which is killed from the smallest shrub and sapling to the stateliest forest tree, is due to bark beetles, and, in the next, that all pines under six inches in diameter are immune from insect attack; and, again, that the death of the trees is due to a certain or, better, an uncertain plant disease, but what disease, or its appearance, or character, he does not know; the only thing of which he is sure being that he is a witness for the defendants, and that it is a disease and not sulphur fumes which cause the destruction—even he will have difficulty in reconciling the destruction by forest insects and unknown diseases of the crops, garden truck, flowers, grasses and weeds which wither and die after a single appearance of the fumes, unless he can classify sulphur dioxid injuries and sulphurous acid blight into conditions "the pathological importance of which have not been determined," and chemical effects into bacteria and unknown diseases.

No vegetation within the region is immune from the effect of the sulphurous fumes, and the destruction extends from the tiniest garden shoot or sprig of grass to the monarchs of the forests, the rapidity of the destruction depending upon the power of the particular plant to withstand the gases. In the affidavits relating destruction by a single visit of the fumes, practically all forms of vegetation common to the region are included.

DEFENDANTS' EXPERTS.

The only experts produced by defendants are two foresters, B. E. Fernow and C. A. Schenk, and three assistants to Forester Schenk on the Vanderbilt estate near Asheville, N. C., who argue, rather than testify, that no great damage has been done by the sulphur fumes. The premises upon which their conclusions are based are different, but all make a "general argument in refutation" of the bill and arguments heretofore filed by complainant, as frankly admitted by Forester Fernow, the leading expert for the defense. (Defendants' Original Record, page 156.) The arguments of Mr. Fernow, however, in so far as they dispute the allegations of the bill, are directly contradicted by bulletins issued by him while connected with the U. S. Division of Forestry (Complainant's Record, pages 76 to 85), and in his book, "Economics of Forestry," recently published, and which will later be quoted in answer to statements in his argument.

Forester Schenk, in his first affidavit, admits the injury in 1905 to extend over about 130 square miles of Georgia's territory (Defendants' Original Record, page 168), but in a subsequent affidavit dismisses the subject by declaring the forests of North Georgia to be utterly worthless, and further declaring that the landowners are actually benefited by the destruction of their timber, as the ground is thereby cleared for pasturage. (Defendant's Record II, pages 5 and 10.) He asserts the region only fit for pasture, notwithstanding the fact that it requires a much higher grade of soil to produce pasturage than it does to sustain a most vigorous forest growth, and the further fact that repeated experiments by the Department of Agriculture, Bureau of Forestry and Geological Survey (of which experiments he certainly knows, or should have known, having been employed on the Vanderbilt estate within the general region at the time), fully developed that even with selected seed the land was found unavailable for pasture, as

no grasses could be grown the sod of which was sufficiently strong to hold the soil and prevent its erosion. (Complanant's Record, page 87.) Had it been otherwise, the topography of much of the region renders it unavailable by reason of its slope. This is pointed out by defendants' witness, Fernow, in his "Economics of Forestry," page 123, in which he declares that mountain slopes in excess of 20 degrees are unfit for pasturage, but at 40 degrees, and even steeper, they afford satisfactory forest conditions. As to farm injuries, Forester Schenk states that, while the crops may be damaged by the fumes, the farmers willingly suffer the injury, as they can sell anything which escapes annihilation to defendants' employees. (Defendants' Record, Vol. II, page 8.)

Assistant Howe pins his faith and bases his argument on bark beetles and unknown plant diseases (Defendants' Record, Vol. II, page 11), and Assistant Mosenthal to pictures of trees selected by him in conjunction with poor soil, forest fires, unrestricted pasturage, and the finding of one case of blight in a group of peach trees at Morgantown, Georgia, the latter apparently being his chief reliance, as it alone is undersored or italicized. (Defendants' Record, Vol. II, page 14.)

Assistant Clancy (Defendants' Record, Vol. I, page 1) admits that the dead timber found within the region has been killed in the past year or two, but guesses the cause of destruction to be insects and unknown diseases, coupled with forest fires deliberately started by the inhabitants of the region. He concludes that the whole destruction from whatever cause is of little moment, as, in his estimation, the timber is valueless except for firewood, and the copper companies, through their employees, furnish a market for such. He also make the discovery that Georgia's citizens bear any fume injury which may occur willingly and without complaint, and in grateful recognition of the market for firewood afforded by the employees of the defendant companies.

Most of the arguments advanced are so palpably without foundation of fact that they verge upon the ridiculous. A few

acres of forest would supply the defendants' employees with fuel throughout the year, yet these experts in all seriousness testify to a market for firewood of hundreds of square miles of ruined forest. The alleged market for crops, which the farmers can not raise, is in keeping with the logic of the general argument, as is also forest injury by unknown and unidentified diseases, and the wanton destruction of their own property by the inhabitants of the region. It requires a most vivid flight of the imagination to picture these people burning thousands of acres of forest in order to possibly pick up with greater ease chestnuts which may have fallen to the ground.

By their own showing, the insect theory is equally untenable. The only destructive insect the defendants' experts claim their investigations to have disclosed is a pine bark beetle, the dendroctonis frontalis, which only attacks one species of forest tree, the pine, a timber affording, according to defendants' witnesses (Defendants' Record, Vol. II, page 17), but 1¾ per cent. of the forest, and of which timber only that over six inches in diameter at breast height is subject to insect attack. (Defendants' Record, Vol. II, page 12.) Complainant has shown by the entomologists for the United States, for Louisiana and for Georgia, and by the United States foresters and others, that these insects have as yet attacked no timber but that dying or weakened by the sulphurous gases.

These experts of defendants in their argument studiously avoid a classification of soils or the distinction between soils fit for forests alone and those fit for forests or pasturage or agriculture generally. They fail to point out the fact that the topography of a region may demand forests for the protection not only of the region, but the surrounding country, and that wood products alone are available from soils with a slope of more than 20 degrees. Nothing is said of soil erosions of declivities having only the sod cover to prevent erosion. Any exposition of forest influences is conspicuous only by its absence. Could it be that these witnesses knew of none of these facts, or was it that any facts in this connection would nullify their arguments for the defense?

Certainly no forester having a right to the title of forester could be ignorant. The witness, Fernow, in his work on the "Economics of Forestry," published but a short time before his affidavit was given, has shown that he was fully conversant with all these facts, for they are clearly stated by him. The following quotations are taken from his book:

"The silviculturist draws from these facts, regarding the frugality of forest crops, the conclusion that he need not like the farmer manure nor change his crop, provided the litter is left, and moreover that he can grow his crops on soils which are not available for agriculture."

"This fact, which also refers to soils and situations that are topographically unfit for plowing, is one of the greatest importance to the political economist. For the increased need of food supplies, the necessity of using soils to their utmost, and the possibility of relegating non-agricultural soils to forestry use is a welcome aid in the solution of the problem."

"Hence, also, the mountain slopes, the very places where, for the sake of favorable water conditions, a forest cover is needed, are par excellent forest lands; for a slope of 15 degrees makes them unfit for plow land, and one of from 20 degrees to 30 degrees excludes them from use as pastures, while forest growth will still maintain itself satisfactorily on slopes of 40 degrees or more."

"We come here to a recognition of a natural subdivision of our soils into *absolute* forest soils, those which are only fit for forest crops, and *relative* forest soils which may come into competition with pasture and farm use, and which require careful consideration as to which use is financially or for other reason preferable." (Pages 121-2-3.)

"In the well-ordered state the soils most fit for agriculture should be devoted to systematic food production, but just so should the non-agricultural soil be devoted to the systematic production of wood crops; moreover, as we have seen, the forests in certain situations exercises a potent influence upon cultural conditions. Hence, the knowledge of the forest extent of a country is of itself meaningless; the character of the soil the forest accompanies, its topographical location and its relation to the hydrography of the country must be known to permit an estimate of the cultural conditions." (Pages 243-244.)

"A grass cover may also protect the soil underneath against the erosive action of the waters, whenever the declivity is not too steep, but since the rains do not penetrate through dense green swards of the mountain meadows, and hence are carried off superficially, they acquire a momentum which finally leads to the same gullying and erosive action which a naked soil experiences." (Page 76.)

"Summarizing the present knowledge of forest influences and reviewing it from the standpoint of the practical economist, it will appear that there is sufficient evidence of the value of properly located forest area as affecting at least water and soil conditions in a marked degree and, in a minor degree, health and climatic conditions, to make the subject of forest conservancy one of great importance. Especially is this the case with the forest cover on mountain sides and in the hill country, where the destructive tendencies of the water are apt to gather force if not modified by the obstructions of the forest floor."

"The protection of the soil cover at the headwaters of streams thus becomes a concern of State activity, and the establishment of forest belts in drought-ridden communities, or the fixing of sand dunes and drifting sands, becomes a public work of internal improvement." (Page 80.)

"The influence which the existence of a forest cover as surface conditions of the soil exerts upon soil conditions, temperature conditions and water conditions, by virtue of which we may characterize them as protective forests. While the most economic use of the soil for material production necessitates the relegation of forests to the poorer soils, protective conditions necessitate its relegation to certain localities." (Page 57.)

Immediately following the last quotation is an extensive discussion of the disastrous effects upon the outlying agricultural districts occasioned by deforesting the mountains, the ruin thereby of valley farms by debris and erosion, and the general effects asserted by complainant in its bill. In fact, this witness in his argument for forest protection as a forester at large so thoroughly answers his argument as an expert for the defense that further comment is unnecessary.

The other witnesses have apparently not expounded their knowledge of forest uences in a text-book for the benefit

of students, as an expert at large rather than for any litigant, but notwithstanding this we can hardly suppose the remaining experts to be utterly ignorant of these important forest facts.

One other explanation of the forest destruction is offered by some of the defendants' witnesses, who attribute same to charcoal burners, because axe marks are found upon some of the stumps within the region. These witnesses, however, overlook the fact that no charcoal has been used within the region for thirty years, and prior to this time the extensive use of charcoal is a mere matter of surmise. This could in nowise account for the annihilation of all vegetation which would have sprung up in the intervening years, even if the charcoal theory was admitted. Furthermore, the decay which follows the cutting of timber would long ago have removed all the evidence of axe marks upon stumps, for both axe marks and the stumps themselves would have disappeared.

That axe marks showing that some of the timber had been cut is but the normal consequence of the fume destruction. Nothing could be gained by allowing the timber to stand until it fell from decay, and frequently the dead timber becomes a menace to the safety of the inhabitants of the region. A number of road commissioners and citizens testify to the necessity of extra road hands to keep the dead and dying trees cut from the roadside, in order to preserve the safety and unobstructed passage over the highways.

And, again, what is more natural when the timber has been killed and only utter loss can follow allowing it to stand, that the landowners should seek to utilize as much of it as possible, should fell the dead trees for use as firewood, fence rails and otherwise, and, if possible, for sale to any purchaser where the haul would not make the cost greater than the purchase price. The destruction has been so widespread and far-reaching that only a small per cent. of the timber killed could be so utilized, but where it has been feasible many of Georgia's citizens have so sought to save what they could in this way from the general loss.

FOREST FIRES.

There have been within the injured territory about the average small forest fires common to the mountain forest regions of America. There have been no great forest conflagrations, so frequent and destructive in the forests of the West. The North Georgia territory is sufficiently thickly populated, and its topography is such that the citizens can and do protect themselves against any extensive fires. Occasional small fires could not be wholly guarded against, especially since the defendants, through their operations, have made the region particularly prone thereto.

To illustrate the far-reaching effect of defendants' fumes in this connection, it is shown in the report, "The Southern Appalachian Region," that the mere fact of a hillside facing to the southward so that it would receive the maximum amount of sunshine and experience the fullest heat of the sun toward drying out its forest floor rendered such hillsides particularly susceptible to fires, from which they suffered much more heavily than localities not so situated. (Complainant's Record, page 87.)

The destruction of vegetation by the fumes has created a similar and infinitely greater tendency to fires throughout the entire zones of injury than was ever experienced by the southern slopes before the fumes made their appearance. The vegetation within the region has been killed by the sulphur dioxid in the spring and early summer and by midsummer the forest floor is covered by dry, dead leaves which theretofore did not fall until the frosts, rains and snows of the autumn had set in. (Complainant's Record, pages 64, 87, 263, 266, 284.)

Since the fume destruction the forest floor is no longer protected by the foliage of the forest from the hot and direct rays of the sun. The humus of the forest floor is no longer moist and damp and unsusceptible to fire, for all moisture is now quickly evaporated. Not only do the fallen dead leaves offer

a most convenient starting point for fires, but the humus generally is rendered dry as tinder, and in consequence of these conditions throughout the injured region a conflagration during the entire dry season is constantly invited. The watchfulness of the inhabitants alone has prevented great damage by forest fires being added to the other injuries suffered by them.

TESTIMONY BY INHABITANTS OF THE GEORGIA DUCKTOWN REGION.

The testimony of Georgia's inhabitants within the Ducktown region was taken at two different periods, the first covering injuries up to and through the summer of 1905, before the new furnaces and tall stack of the Tennessee Copper Company were erected; the second embracing injuries during the spring and summer of 1906, after six months' operation of the new furnaces and chimney.

In the first class fifteen hundred witnesses were produced, who testified to the general destruction of vegetation within the localities in which they resided, who identified the fumes produced by the defendants, their appearance, foul odor, sickening effect, and even taste when specially strong, and who declare the frequent appearance of the gases within the region then affected. (Complainant's Record, pages 138 to 445.)

A number of citizens also relate the destruction of crops, gardens, flowers and vegetation generally coincident with the single appearance in strength of the sulphur dioxid then generated by the Tennessee Copper Company in its three furnaces and small stack, and by the works of the Ducktown Company. (Complainant's Record, pages 140, 145, 166, 172, 188, 198, 216, 223, 242, 245, 278, 289, 293, 312.)

The second set of affidavits embrace more than two thousand witnesses, who relate each of the injuries specified in the first instance, and declare the vast increase in the spring and summer of 1906 of all forms of damage, and also in territory sub-

ject thereto. Many of the witnesses further declare that they were theretofore familiar with the fumes and fume injuries in localities other than their own places of residence, and that their neighborhood had suffered from the effects of the sulphurous gases for the first time in 1906. (Complainant's Record, pages 452 to 844.)

Numerous witnesses relate the destruction during the same period of all forms of vegetation, ranging from grasses, flowers and garden truck to whole hillsides of timber, by a single visitation of the fumes. Many of these cases of destruction occurred in localities which, prior to 1906, had been immune to fume injuries. (Complainant's Record, pages 551 to 373, 622 to 640, 679 to 724, 734 to 744, 750 to 820.)

All these witnesses declare that the first evidence of this general destruction, of sulphur dioxid injuries, was from five to six years ago and coincident with the opening of the Tennessee Copper Company's plant and the increased operations by the Ducktown Sulphur, Copper & Iron Company.

CHARACTER OF THE WITNESSES AND MANNER OF TAKING TESTIMONY.

The witnesses produced by the complainant include judges, county officials, doctors, lawyers, teachers, ministers, farmers, lumbermen, and practically all other walks in life represented within the Ducktown region. As shown by their testimony, probably in excess of ninety per cent. are property owners and taxpayers in Georgia, and directly identified with and interested in the welfare of the region and of the State at large. They are, naturally, interested in preserving any and all industries which in any manner aid in building up their communities or which may contribute to their progress. It is this class of citizens who testify to the destruction wrought by defendants' fumes, the ruin of the chief industries of the region, farming and lumbering, the abandonment of farms, and the annihilation of property values.

Of the witnesses produced by the defendants, self-alleged citizens of Georgia, only a most insignificant number pay any taxes within the State. In fact, less than one-tenth own any property whatever or pay any taxes, either real, personal or poll, or are registered citizens or voters within the State of Georgia. (Complainant's Record, pages 406, 407, 416, 417, 420, 421, 833, 834, 835.)

A large majority of defendants' witnesses are identified as employees and dependents of defendants, men who were made to believe that they were threatened with loss of employment under the relief sought by complainant, and who were given holidays at full pay to go into Georgia and hold mass meetings of protest in the guise of citizens of the State, and otherwise seek to stir up sentiment against complainant's suit herein (Complainant's Record, pages 828, 832). These are the witnesses, about from six to seven hundred in all (as against approximately four thousand produced by Georgia), who have failed to note the forest destruction, injury to vegetation, damage to roads, and other conditions related by complainant. It is worthy of note that none of these witnesses qualify as farmers, lumbermen, or otherwise as dependent upon the products of the soil for their livelihood. They claim to be citizens of Georgia, but a careful examination of the county records fails to disclose their citizenship, or that they are taxpayers or entitled to vote within the State. Most striking of all is the fact that of all these so-called inhabitants of Georgia, but twenty-five make affidavit within the State, and of this number twenty-four are residents of Murray county, the county which, by reason of high intervening mountains, is best protected against the ravages of the fumes.

Since the operation of the new furnaces and high stack by the Tennessee Copper Company and the vast increase of damage thereunder, Georgia has produced more than two thousand witnesses who testify to the enormous increase both in injuries and territory subject thereto. To cover the injuries within the same period the defendants have produced about one hundred

employees and residents of the mining camps, who declare that conditions have improved in the immediate vicinity of the plants, an improvement which Georgia's experts and counsel heretofore predicted, and one made at heavy expense to Georgia and her citizens; and also about a baker's dozen or so of Georgia's inhabitants who have testified to the injury, but who declare they desire the plants to condense or otherwise take care of their fumes and not close down.

The manner in which the evidence for complainant was procured further illustrates the interest of the people of the Ducktown region in this litigation. This is developed by Martin Vogel, counsel for the defendant, the Tennessee Copper Company, in his affidavit filed in this cause (Defendants' Record, Vol. II, pages 28, 29), in which it is shown that the area of injury in 1906 was so large and the residents thereof so widely scattered, they being mainly farmers, that it was impractical for complainant's counsel to canvas the region in order to secure the testimony for this cause. For this reason a number of county officials competent to take acknowledgment of affidavits tendered, without charge, their services to the State and offered to take the affidavits of all citizens who came before them, in whose interest as well as its own the State had filed its bill. Some of these officials, such as sheriffs and tax-collectors, had frequent occasion to travel through the fume damaged territory, and a circular was issued to the citizens of Northern Georgia telling them of the tender by such officials of their good offices in the premises and requesting all citizens living within the Ducktown region to make affidavits before them of the conditions existing therein. It was in this manner, by voluntary appearance before commissioners acting wholly gratuitously, and not by solicitation of counsel or bailiffs paid to secure evidence, that complainant's testimony herein was secured.

FOREST INFLUENCES.

The simple loss through the great direct and wanton destruction of property by the sulphur fumes is but a minor consideration in the efforts of the State to preserve the forest and vegetation of Northern Georgia. The ultimate effects of this destruction extend not only to the soil upon the mountain sides, the fertility of the outlying valleys, the roads and highways, preservation from floods and freshets throughout the region, but, more far-reaching than all this, menace the water supply of the State at large, for all the important streams of Georgia find their source in this southern terminus of the Appalachians.

A fair exposition of the general forest influences is made by B. E. Fernow, witness for the defendants, in his book, "Economics of Forestry" heretofore (pages 29, 30) quoted in answer to his argument for defendants; they are also specified at greater length in official bulletins of the United States, quoted in Complainant's Record, pages 76 to 91.

One of defendant' experts gratuitously asserts that Georgia neither has done nor is doing anything to preserve her forest in the mountain regions. The record discloses quite the contrary. Georgia recognizes that the individual efforts of the States can not fully protect the Southern Appalachians and that a concerted action by all States interested is by no means assured, as is evidenced by Tennessee's attitude, necessitating the present litigation. Georgia further recognizes that a single reserve of her own can not wholly preserve the water supply, for the adjacent mountains of Tennessee and North Carolina also exert an influence which, while infinitely less than that of the Georgia mountains, is sufficiently marked to be a matter of considerable moment.

Long prior to the institution of this litigation and before the question of fume injuries arose, the proposed national forest reserve was most strongly advocated by the State of Geor-

gia, acts were passed providing for ceding the necessary territory to the National Government and other action taken by the State and her citizens seeking to aid toward the national protection of the Southern Appalachian forest. (Exhibit, "The Southern Appalachian Region, pages 178, 179, 192.) Delay in action by congress has prevented as yet any provision for this reserve, and complainant, by all the means within its power, is seeking to preserve the North Georgia forests until the power of the national government intervenes to protect not only its mountain region but the entire forest and watershed of the Southern Appalachians.

In this connection complainant desires to call attention to the policy pursued under the establishment of national forest reserves. Within the general territory of the reserve the valley farms are not included but are left to their owners, the forest reserve extending only to the actual mountain regions, to lands topographically unfit for agriculture or necessary to the protection of the water supply, outlying valleys and farm lands, so that while the forests are conserved the agricultural interests of the region are both protected and bettered.

The reports of the government experts who have made full investigation of the Southern Appalachian Mountains, covering forest influences, land erosion, floods and water supply so fully set forth the contentions of the complainant that no argument beyond quotations from these reports is necessary in this connection.

EROSION.

"The forest covering protects the soil in the following ways:

"(1) By preventing rain from falling directly upon the soil, the foliage of the tree crowns intercepting and breaking its force, the water reaching the soil more gently from the leaves and along the branches and trunks of the trees.

"(2) By interposing a loose cover or mulch of litter formed

by the fallen leaves and branches, which breaks the direct force of the raindrops and keeps the soil from being compacted or puddled by their blows.

"(3) The deeply penetrating roots, and holes left from decayed stumps and roots of trees, assist in this underground drainage.

"(4) The litter with the stumps and projecting roots and trunks of trees prevent the water from rapidly running over the ground and from gaining the momentum and force which is necessary in order to erode or gully the soil.

"(5) The forest cover prevents the drifting and the rapid thawing of snow, thereby insuring more even distribution of the waters and an increase in the time during which it can percolate or be absorbed into the soil.

"Just as deforestation of hillsides and hilltops is the first cause for inducing erosive action, so is reforestation the most effecting means in curing the evil. This has been demonstrated in France, where the Government and the farmers together have spent, during the last thirty years, over $40,000,000 and expect to expend three or four times that amount to reforest 1,000,000 acres of denuded mountain sides, the soil and debris from which has been carried by the torrents of water into the plain, covering over 8,000,000 acres of fertile ground and making it useless for agriculture. Sodding for pasture has been found mostly less effective and on the steeper slopes entirely ineffective.

"Wherever the ground in the hill country is not fit for agricultural use it should be set and kept in forest, not only to make it produce a timber crop, but also to prevent the erosion which finally becomes dangerous to the lower valley lands. —(*Farmer's Bulletin, 20 U. S. Department of Agriculture,* Complainant's Record, pages 84-85.)

"By this protection of the soil the so-called torrential action of water is prevented, which, as the history of some departments in Southern France has shown, is capable of devastating thousands of acres of fertile land by carrying the detritus into

the valleys and depositing it there. At the same time the reforestation work of the French Government has also progressed far enough to furnish proof that the reclothing of the denuded hills is the practical remedy against these torrents.

"Not only were the mountain sides themselves devastated and made useless by the destructive action of the water, but fertile farms for 200 miles from the source of the evil were ruined by the deposit of the debris, and the population pauperized and driven out.

"According to M. Demontzey, forest administrator of France, it was estimated, in 1866, that area of denuded mountain lands needing reforestation was 2,964,000 acres. The Government has taken hold of the restoration of the most-needing area, some 780,000 acres, on which so far some $10,000,000 have been expended, while private owners and communities have increased this expenditure for the repair of past follies to over $30,000,000, which is estimated to be about one-half of what is necessary.

"How in our own country this erosive and destructive action of water is at work, even in the hill country, is thus graphically described by Mr. McGee, in speaking of the bad lands in the State of Mississippi.

"With the moral revolution of the early sixties came an industrial evolution; the planter was impoverished, his sons were slain, his slaves were liberated, and he was fain either to vacate the plantation or greatly to restrict his operations. So the cultivated acres were abandoned by thousands. Then the hills, no longer protected by the forest foliage, no longer bound by the forest roots, no longer guarded by the balk and brush dam of the careful overseer, were attacked by raindrops and rain-born rivulets and gullied and channeled in all directions; each streamlet reached a hundred arms into the hills, each arm grasped with a hundred fingers a hundred shreds of soil, and as each shred was torn away the slope was steepened and the theft of the next storm made easier.

"So, storm by storm and year by year, the old fields were invaded by gullies, gorges, ravines, and gulches, ever increasing in width and depth until whole hillsides were carved away, until the soil of a thousand years' growth melted into the streams, until the fair acres of ante-bellum days were converted by hundreds into bad lands, desolate and dreary as those of the Dakotas. Over much of the upland the traveler is never out of sight of glaring sand wastes where once were fruitful fields; his way lies sometimes in, sometimes between, gullies and gorges—the "gulfs" of the blacks, whose superstition they arouse, sometimes shadowed by foliage, but oftener exposed to the glare of the sun reflected from barren sands. Here the road winds through a gorge so steep that the sunlight scarcely enters, there it traverses a narrow crest of earth between chasms scores of feet deep in which he might be plunged by a single misstep. When the shower comes he may see the roadway rendered impassable, even obliterated, within a few minutes; always sees the falling waters accumulate as viscid mud torrents of brown or red, while the myriad miniature pinnacles and defiles before him are transformed by the beating raindrops and rushing rills so completely that when the sun shines again he may not recognize the nearer landscape.

"This destruction is not confined to a single field nor to a single region, but extends over much of the upland. While the actual acreage of soil thus destroyed has not been measured, the traveler through the region on horseback daily sees thousands or tens of thousands of formerly fertile acres now barren sands; and it is probably within the truth to estimate that ten per cent. of upland Mississippi has been so far converted into bad lands as to be practically ruined for agriculture under existing commercial conditions, and that the annual loss in real estate exceeds the revenues from all sources. And all this havoc has been wrought in a quarter century. The processes, too, are cumulative; each year's rate of destruction is higher than the last.

"The transformation of the fertile hills into sand wastes is not the sole injury. The sandy soil is carried into the valleys to bury the fields, invade the roadways, and convert the formerly rich bottom lands into treacherous quicksands when wet, blistering deserts when dry; hundreds of thousands of acres have thus been destroyed since the gulleying of the hills began a quarter century ago. Moreover, in much of the upland the loss is not alone that of the soil, *i. e.*, the humus representing the constructive product of water and plant-work for thousands of years; the mantle of brown loam, most excellent of soil stuffs, is cut through and carried away by erosion and sapping, leaving in its stead the inferior soil stuff of the Lafayette formation. In such cases the destruction is irremediable by human craft—the fine loam once removed can never be restored. The area from which this loam is already gone is appalling, and the rate of loss is increasing in a geometric proportion.—(*Bulletin 7, U. S. Department of Agriculture,* (Complainant's Record, pages 78, 79, 80.)

"In the cool climate of New England the native grasses form a dense sod which holds the hillside surfaces in place, so that even when forests have been removed there is little erosion. In the Southern Appalachians, however, neither the grass, the legumes nor other foliage plants have been able to prevent this land erosion, and their only safeguard for the future is the protection of the forests. Hundreds of these steep mountain fields where selected grasses were sown have been observed during the past few years, and the results as a means indicating a means of permanent holding of these soils have been generally unsatisfactory. (See Plate XXII.) * * * * While the rains are removing the soils of the cleared mountain slopes, the floods are removing the soils of the valley farms. This is notably the case in the valleys where the bordering forests have been cleared to the largest extent. Year by year the channels of the streams are widened and encroach upon the adjacent farms, and, as the magnitude of the floods increase, plow new channels across the fields. During the

present year thousands of acres of the most productive valley lands in this mountain region have been damaged or destroyed by one or both of these processes." (See Plates XXIII and XXIV.)

"The rainfall in this Southern Appalachian region, as shown by appendix D, ranges from 60 inches for the year in Georgia to 71 inches in North Carolina. Heavy rainfalls in short periods are common. Even in an arid or semi-arid region, where the rainfall for the year may be only ten inches or less, the absence of forest cover results in a slow but sure removal of the soil from the mountain slopes. Much more in a region of heavy rainfall, like that of these southern mountains, when the forest cover has been destroyed, will the soil removal be certainly and rapidly accomplished."

"The soil once denuded of its forests and swept by torrential rains, rapidly loses first its humus, then its rich upper strata, and finally is washed in enormous volume into the streams to bury such of the fertile lowlands as are not eroded by the floods, to obstruct the rivers and fill up the harbors of the coast."—(*Bulletin, "The Southern Appalachian Region,"* Complainant's Record, pages 87 to 90.)

"This erosion is especially detrimental to agricultural interests as well as water-flow in regions with this surface and impenetrable subsoils, and where rains are apt to be explosive in their occurrence, as in our western and southern country, the best soil of the farms is often washed into the rivers, and the water stages of the latter by the accumulations of this soil are influenced unfavorably.—(*Bulletin 7, U. S. Department of Agriculture,* Complainant's Record, page 82.)

"The agricultural resources of the Southern agricultural region must be protected and preserved. To that end the preservation of the forests is an indispensable condition which will lead not to the reduction, but to the increased yield of agricultural products."—(*Bulletin, "The Southern Appalachian Region,"* Complainant's Record, page 90.)

Even more convincing than the testimony of the govern-

ment experts are the photographic illustrations offered. In exhibit "The Southern Appalachian Region" are contained numerous reproductions of photographs showing the soil erosion following forest destruction. Especially striking are views, **plates I, IX^b, XX, XXI, XXII, XXIII, XXIV, XXXIV, XXXV, XXXVI.**

Soil erosion starts just so soon as the forest becomes too thin for its roots, humus and forest floor to protect the soil. Occasional trees are of practically no value. Two of the views referred to demonstrate the falsity of the claim that only by complete forest destruction is harm done. By plates XXI^b and XXII^b it is conclusively shown that some of the forest may remain and yet by erosion the soil is ruined, by rains the detritus is carried to lower lying regions and the value of the locality in the matter of water supply almost if not utterly destroyed. It is also worthy of comment that the two plates specified embrace localities far less declivitous than the average mountain regions, and, therefore, less susceptible to washing.

Still more forceful than these views are the direct pictures of the Ducktown region produced by complainant (Exhibits of R. I. Smith, and Bureau of forestry pictures Nos. 63032, 63041, 63040 and 63038) showing the soil erosion, as are also the pictures exhibited by defendants (Exhibits A, B and C. Defendant's Original Record, final pages). These pictures disclose mile upon mile of territory utterly barren and devoid of any vegetation whatsoever, with the top soil gone and the subsoil gullied and washed, and dreary and desolate as a desert waste. This condition of desolation radiates from the copper plants, gradually improving as the distance increases. The only localities anywhere near the works in which complete erosion has not occurred is along the river bottom just above the plant of the Tennessee Copper Company and upon the hill immediately across the river from same, from which some of the large photographic exhibits of complainant are taken. These locations are badly washed but the entire soil has not

yet been eroded. The air currents caused by the river in its downward flow seem in some manner to have kept the fumes from falling or remaining stationary over these places. It will be noted that all bushes and river growth on the bank of the river nearest the plant has been utterly destroyed while that along the opposite side is the only uninjured or slightly injured vegetation for miles. At all adjacent localities except these the erosion is shown to be general.

FLOODS AND FRESHETS.

"Upon these mountains descends the heaviest rainfall of the United States, except that of the Northern Pacific coast. It is often of extreme violence, as much as eight inches having fallen in eleven hours and 31 inches in one month, 105 inches in a year."—(*Bulletin, "The Southern Appalachian Region," Complainant's Record Page* 90, *also "Water Supply and Immigration Paper* 62," Complainant's Record, page 83.)

"A difference of 1,000 to 2,000 cubic feet of water per second from a square mile of watershed may often determine whether a dangerous flood is experienced or not. And since a square mile of moss-covered forest floor is capable of absorbing from 40,000,000 to 50,000,000 cubic feet in, say, ten minutes (a humus cover is capable of taking up 50 per cent. of its own weight), nearly all of which the naked soil would give up some twelve to fifteen hours earlier, the surface conditions of the watershed must in many cases be determinative in the excesses of water-flow in rivers.—(*Bulletin 7, U. S. Department of Agriculture,* Complainant's Record, pages 77-78.)

"These mountains will continue the home of storms. These heavy rains will continue to drench the slopes, if cleared of their forests, with increasing violence. Whether in the future these rains will be caught by ferns and grass and humus and received by a deep and porous soil, to be given out as needed to the vegetation above and perpetual springs below, or whether it shall rush down bare rocky slopes to fill gorges and carry

destruction through the valleys beyond, depends upon whether or not these forests are preserved."—*"Bulletin, "The Southern Appalachian Region,"* Complainant's Record, page 90.)

"The formation of detritus and deposit in the river beds may also become the cause of dangerous floods in the larger streams, for the amount of rock material and soil which the rivers carry is one of the most potent factors in their waterflow.

"Since this detritus is deposited wherever the velocity of the water sinks below that necessary to carry it, forming sand banks and rubbish heaps which obstruct and change the direction of the run, it plays quite an important part in shaping the bed of the river, beside influencing the whole system of dependent brooks and rivers."—(*Bulletin 7, U. S. Department of Agriculture,* Complainant's Record, page 80.)

WATER SUPPLY.

The vast importance of forest preservation in conserving the nation's water supply has but recently become generally apparent in America. To the public at least for many years the forest seemed inexhaustible and not until the great floods began inundating enormous areas, carrying with them terrific loss of life and property and being followed by droughts, drying up of streams and loss of water supply did the States or the nation profit by the experience of Europe and seek to preserve the timber growth at the source and near the headwaters of their streams.

The only controllable factor in the fight against the ravages of the elements, the destruction of the fertility of the soil and the ruin of the country's water power and supply rests in the preservation of the forest.

One of the first bulletins of the United States in this connection is by B. E. Fernow, chief expert for the defense, then with the United States Division of Forestry, in which it is stated:

"This important fact should at least be recognized, that the surface conditions of the soil of a watershed are the only controllable factors in the problem." (Complainant's Record, Page 78.)

"An element tending to increase the amounts of subterranean drainage waters lies in the retardation of the surface flow, by which the time is lengthened during which the soil may take up and filter through rain and snow waters."

"The forest floor offers such impediments to surface flow and not only in greater degree than any naked soil, but than any other vegetation. An advantage over other kind of vegetation is also found in the deep penetration of the roots of the trees, which increases the chance for percolation. All that has been said regarding evaporation and transpiration within and without the forest needs also be kept in mind in the discussion of the amounts of drain waters for underground disposal."

"The conclusion, then, is that in general a forest floor, although retaining much of the water in its upper strata, allows less water to run off superficially, and by rendering the soil more permeable, larger amounts of water are turned into subterranean channels."

"The most direct influence of a forest cover upon the discharge would be noticeable on the surface springs, since in these the catchment area and the place of discharge lie close together, while the underground run is not only short, but lies near the surface, and hence experiences most sensibly the effect of the protection against evaporation which the forest cover offers. Deforestation here would no doubt reduce or cut off discharge entirely.

"It is in the first place this mechanical obstruction which a forest floor more than most other kinds of vegetation offers, which changes the distribution in time of surface waters, that constitutes the forest an influential factor in water-flow.

"The great number of inequalities which the forest floor offers, in addition to the trunks and stumps and fallen trees, forces the run-off to many detours, thus retarding its flow and its collection in the open runs and brooks.

"The retardation in the water-flow begins even before the rain has reached the soil, for the leaf canopy catches and re-evaporates, as we have seen, from 12 to 25 per cent. of the total fall, and certainly retards the fall of the water to the

ground, as can be readily observed; long after the rain has ceased the water keeps on dripping from the foliage. Thus, although most of the water reaches the ground at last, except in case of very light showers, yet the devious ways in which it reaches the soil makes the flow of water from a forest-covered hill longer in time than if the rain had fallen on a bare slope. As the result of long-continued precipitation, it would be under the same conditions by an unforested slope, but this stage occurs in the forest later than on unforested soil and later still than on naked soil.

"The great importance of the factor of time in surface drainage, both as regards dangers from freshets and erosion of soil, will be more readily appreciated when we remember that the dangerous waters in the mountains are generally of short duration.

"In consequence of deforestation evaporation from the soil is augmented and acelerated, resulting in unfavorable conditions of soil humidity and affecting unfavorably the size and continuity of springs. The influence of forest cover upon the flow of springs is due to this reduced evaporation as well as to the fact that by the protecting forest cover the soil is kept granular and allows more water to penetrate and percolate than would otherwise.

"Snow is held longer in the forest and its melting is retarded, giving longer time for filtration into the ground, which also being frozen to lesser depth is more apt to be open for subterranean drainage. Altogether forest conditions favor in general larger subterranean and less surface drainage, yet the moss or litter of the forest floor retains a large part of the precipitation and prevents its filtration to the soil, and thus may diminish the supply to springs. This is especially possible with small precipitations. Of copious rains and large amounts of snow water, quantities, greater or less, penetrate the soil, and according to its nature into lower strata and to springs. This drainage is facilitated not only by the numerous channels furnished by dead and living roots, but also by the influence of the forest cover in preserving the loose and porous structure of the soil.

"The forest, then, even if under unfavorable topographical and soil conditions (steep slopes and impermeable soils) it may not permit larger quantities of water to drain off underground and in springs, can yet influence their constancy and equable flow by preventing loss from evaporation.

"The surface drainage is retarded by the uneven forest floor more than by any other kind of soil cover. Small precipitations are apt to be prevented from running off superficially through absorption by the forest floor. In case of heavy rainfalls this mechanical retardation in connection with greater subterranean drainage may reduce the danger from freshets by preventing the rapid collection into runs.

"As a regulator of water conditions the forest of the mountains is the important factor; and since this influence makes itself felt far distant from the location of the forest, the claim for attention of Government activity and for statesmanlike policy with reference to this factor of national welfare may be considered as well founded. Every civilized government must in time own or control the forest cover of the mountains in order to secure desirable water conditions."—(Complainant's Record, pages 76 to 82.)

Subsequent investigations have borne out the truth of this bulletin and further developed the necessity of forest preservation. The Geological survey of the United States, after a comprehensive investigation in part in the very territory now involved, the territory covered being the Southern Appalachians, in Bulletin 80, "Water Supply and Irrigation Papers," makes this report:

"Whatever question there may be as to the influence of forests on rainfall, there is, in the opinion of the writer, none as to such influence on stream-flow. * * * * The removal of forests renders stream-flow less equal throughout the year and so cause floods and periods of dryness in rivers, seems to be beyond reasonable question, for the forest litter and root masses serve as storage reservoirs, tending to equalize the flow of streams."

"So far as present information goes, there is little or no relation between topography and run-off of streams. Deforestation appears to exercise a much more important influence."

"The extent of forestation appears to have considerable effect on the run-off of streams, catchments within dense forests showing larger run-off for the same rainfall than those which are deforested. As a tentative proposition it may be said that the removal of forests notably decreases stream-flow." (Complainant's Record, page 83.)

All this is reiterated in effect in Farmer's Bulletin No. 20, U. S. Department of Agriculture, in which, among other things, it is said:

"Forest ground is not subject to this erosive action of the rainfall because in a forest a large part of the rainfall never reaches the soil, as 20 or 30 per cent. is intercepted by the foliage and evaporated before it reaches the ground. The rainfall which reaches the surface is rapidly absorbed, as the soil is kept granular and loose and much more of the water is carried off by underdrainage rather than by surface drainage."—(Complainant's Record, page 84.)

The most recent investigations involving the relation of forest to water supply were also made in the Southern Appalachians by the Geological Survey and Bureau of Forestry of the United States, involving an extensive and careful examination extending over a period of more than two years with numerous measurements of stream flow within the region, comparisons of water supply from forested with that of deforested areas, and numerous other scientific tests in this connection. From these investigations the necessity of forest preservation was again emphasized, and national forest protection within the Southern Appalachians urged in the following language:

"The perpetuation of streams and the maintenance of their regular flow, so as to prevent floods and maintain their water-powers, are among the prime objects of forest preservation in the Southern Appalachians. Nothing illustrates the need of this more fully than the fact that the neighboring streams, lying wholly in the Piedmont Plateau, when the forests have been cleared from 60 to 80 per cent. of the whole, floods are frequent and excessive. During the seasons of protracted drought some of the smaller streams almost disappear, and the use of water-power along their course is either abandoned or supplemented by steam-power. To-day the larger valuable water-powers of the South Atlantic region are mainly limited to the streams which have their sources among the Southern Appalachian mountains; and the waters of these streams show a striking uniformity of flow as compared with the streams within the adjacent lowland country where the forest clearing

has been excessive. While the rainfall is somewhat greater in the mountain region, it is a question of the regularity rather than the volume of the flow, and this depends upon the water storage. The soil in the one region is as deep as in the other, and the slopes being gentler in the low country, other things being equal, water would soak into it more easily. In the mountain region itself the flow of the streams along which proportionately large clearings have been made have become decidedly more irregular, and the flood damages have greatly exceeded those along other streams where the forests have not been disturbed. The problem resolves itself into one of forest cover for the soil."—(Complainant's Record, pages 88, 89.)

The foregoing quotations from reports based upon scientific investigation so clearly show the forest influence upon the water supply that it is deemed only necessary to call further attention to the fact that under the present ratio of increase in fume injury hardly one more summer will be needed to extend the fume effects to almost if not the entire source of the water supply of the State of Georgia. Should this occur, bringing with it the conditions which now exist in the Ducktown basin, a cessation of the fume production will not mean an immediate cessation of the harmful effects realized through their past destruction. Years will be required to reforest the area already denuded of vegetation and with each increase of the zones of injury not only will greater damage to Georgia's water supply be done but manifold difficulties will be added to the efforts seeking to remedy the harm already accomplished. In fact, along the slopes where complete soil erosion has occurred, reforestation is impossible until the disintegration of the underlying rocks permit the reformation of a top soil, and where the erosion is but partial or even barely begun, the task of preserving the mountain slopes is both great and expensive and hardly to be successfully accomplished within the span of the average lifetime.

RESULTANT INJURIES TO ROADS AND HIGHWAYS.

The northern part of the State of Georgia is not sufficiently populated, nor for that matter are but few localities within the State or the South, other than in the immediate vicinities of the larger cities, to warrant the building of macadam roads. The highways generally throughout the mountainous regions of North Georgia are through forested areas or protected valley bottoms and, although but the ordinary dirt roads, they were before the advent of defendant's fumes reasonably protected from the ravages of the elements and damage and blocking by dead timber.

Since the fume effects have become general conditions have materially changed. Special road hands have become necessary to keep the dead and dying timber cut from along the roadside and, worse than this, the highways have suffered heavily from erosion. Road construction necessarily demands the removal of all humus, roots and vegetation tending to hold the soil together, leaving the roadways wholly at the mercy of the rains and floods unless protection is offered by the neighboring forest.

The effect of forest destruction upon roads is clearly pointed out by Road Commissioner Harper. (Complainant's Record, page 223), who testifies:

"The timber throughout said locality has been killed with great rapidity. Often the dead trees along the roadside constitute a menace to the passers thereupon. In the locality where all the timber has been killed and the vegetation practically destroyed, the roads wash very badly, there being frequent holes, gullies and unsafe places occasioned thereby. The fact that there is no vegetation to hold the soil or to restrain the water as it runs down the hillsides is responsible for this condition and for the exceptional damage to the roads. This is especially true of those roads in the northern part of the county and in the locality of said furnaces.

"Deponent is a Road Commissioner of said county, whose

duty it is to see to the safety of said roads as well as their condition. The facts heretofore recited add greatly to the expense in the maintenance of said roads, as well as the difficulty of keeping said roads in repair. The conditions are much more difficult and arduous than those existing prior to the extensive operations of the Tennessee and Ducktown Copper Companies.

The testimony of Road Commissioner E. W. Wilson (Complainant's Record, page 300) is to the same effect. This witness declares:

"I have to keep a constant lookout for dead timber and have cut a lot and have to go outside of road, leave it and cut timber. The end of my road nearest Ducktown washes much more than it did some years ago when there was plenty of timber on said road."

Road Commissioner T. J. Wilson (Complainant's Record, page 240), states:

"Deponent is a Road Commissioner of said county, in which he has lived for forty-nine years. The safety of the roads and free passage thereover is only maintained by the constant watching for and cutting out the timber killed by the sulphur fumes. This is only done upon the main roads, as the county has not sufficient hands to cut away the timber upon the meeting or mill roads, or roads other than the main public thoroughfares.

"As a result of the death of the vegetation, the roads are frequently injured, holes and gullies, and well-nigh impassable washouts being made therein by reason of the fact that the hill and mountain sides are bare, there being no vegetation to restrain or take up the water precipitated thereon, the same running off as rapidly as it falls, and causing freshets and flooding of creeks, gullies and branches in said locality."

The affidavits of many citizens declare the general injury to the roads. Among those whose affidavits are particularly in point are L. V. King (Complainant's Record, page 245), Richard Woolfork (page 310), and W. G. Thomas, John Warren, L. W. Smith, T. A. Terrell, J. C. Long, H. P. Legg, W. A. Davies, A. S. J. Ledford, D. M. Buchanan, R. M. Chastain, R. L. Phillips, J. H. Long, W. R. Godfrey, W. R. Cook (page 369), and many others.

Witness King states:

"I wagoned considerably during winter and spring. The roads were washed out in holes and gullies, more especially in the direction of Ducktown. The roads in the north part of the county are generally in this condition. Dead trees have fallen in the road, and deponent was compelled to leave the public road twice on that account. Timber along the road is dead and dying."

Richard Woolfork declares:

"In localities where all the timber has been destroyed, as well as much vegetation, the lands wash badly. This is particularly true in the hilly portions and other than the valleys. A considerable portion of said country is steep and sloping. There being nothing to retain or obstruct the water, it runs off almost as rapidly as the same falls upon the ground, and the roads especially suffer from this condition, and are badly washed and frequently rendered dangerous in consequence thereof. In addition, the roads require infinitely greater care and attention, and are much more trouble and expense to keep in repair than roads in localities not subject to such conditions."

W. G. Thomas and others say:

"In some sections and localities the entire timber and vegetation has been killed and destroyed, and in these localities by the killing of all the timber and vegetation the top soil, especially in hilly and sloping places, suffers greatly from washes, as do, in consequence, the roads and highways, holes, gullies and washouts being caused thereby, and the roads otherwise injured and damaged."

The foregoing testimony would seem to make unnecessary any further comment upon the question of whether or not there had been injury to Georgia's roads and highways. The inconvenience and discomfort occasioned by the foul odors thereon will be hereafter discussed. (Pages 57, 58.)

ABANDONED LANDS.

Hundreds of witnesses produced by complainant swear that if the sulphur fumes continue farming and lumbering within the zone of injury will soon be a thing of the past. Most of the inhabitants of the regions are farmers, and probably in excess of ninety per cent. of the total population are dependent upon the products of the soil for their sustenance and livelihood. The real property of the region is practically valueless, except with reference to farming and lumbering.

While the inhabitants of these North Georgia counties are, as a rule, people of limited means, they are thrifty and industrious, and a large majority of them are their own landlords, a as complainant's testimony discloses. Usually their savings are invested in their farm and home, the farm growing in proportion to the increased earnings of the owner, and with a destruction of these comes poverty and want. If the complainants are to continue uninterrupted in their operations these people will be forced to abandon their property and, if their years permit, seek new localities in the hope of making a support for themselves and their families; if too old for this, then their friends, who are in no better financial situation than they, or the State must maintain them, for not only is their occupation destroyed, but their capital, which might otherwise have permitted a new one, is gone and they are left upon the charity of the community.

The abandonment of property is not a thing merely threatened, but one which has already occurred, and has reached large proportions. In the two fiscal years of 1903-1904 and 1904-1905 the large amount of 47,391 acres of cultivated and farm lands were abandoned and allowed to lapse into a wholly wild and unproductive state. In the past year, with its great increase in injuries, the enormous amount of 86,415 acres, about one hundred and thirty square miles of farms, were abandoned, almost double the total of the two preceding years

(Complainant's Record, pages 94 to 97). This abandonment was the only course left to many a farmer in the Ducktown region, for the fume destruction has made further efforts at farming worse than useless, a sale of the land impossible, and the land not worth paying taxes to retain.

With this abandonment has come the consequent decrease in taxes, and with the general injury a decrease in property values throughout the whole territory. The people were slow to believe that such a thing would continue and until recently kept up their hopes and their taxes, but the decline has begun and will grow rapidly with the continuance of the fumes. Fannin and Gilmer counties, in which the heaviest abandonment has occurred, have suffered heaviest in tax decrease. But a short time will be required to cut the income from these counties in half. They would now, in fact, show a much heavier decrease but for the increase of property values through the Louisville and Nashville Railroad, which has added to the general wealth of these counties.

The decrease in value and tax returns has been experienced in the face of a large and almost uniform increase throughout Georgia, particularly in the timber and agricultural regions. As shown by the Commissioner of Agriculture for Georgia, the lands throughout the State in the past five years have increased from fifty to one hundred per cent. in value. (Complainant's Record, page 232.)

FUME INJURIES TO HEALTH AND COMFORT.

That the fumes of the defendants are destructive to health and comfort, and prevent the inhabitants of the region from the full enjoyment of their homes and property ,is no longer an open question. These fume results have been judicially declared by the Supreme Court of Tennessee in the case of Madison *v.* Copper Companies, 113 Tenn. 340, and it is respectfully suggested that the question of the fume effect in this connection is now res adjudicata.

In addition to this, however, a number of Georgia's inhabitants testify to effects identical with those declared in the Madison case. (Complainant's Record, pages 146, 174, 204, 210, 300, 301, 408, 428.) The fumes produce severe irritation of the mucous membrane, headache, coughing, and, to persons with weak lungs, mean death or the quick removal from their influence. The description of sulphur dioxid and its effects by the Encyclopaedia Americana, Vol. XV, is as follows:

"Sulphur dioxid is a colorless gas with the familiar suffocating odor of burning sulphur. It is irrespirable in the pure state, or even when largely diluted with air. Mere traces of it when inhaled for some time produce inflammation of the mucous surfaces of the respiratory tract and of the stomach, followed by nausea."

Another and far-reaching danger to health has resulted from the destruction of vegetation in the early spring and summer and the parching of the humus of the forest floor. Since these results have appeared severe epidemics of typhoid fever have occurred throughout not only the Ducktown territory, but the adjacent regions (Complainant's Record, pages 428, 429), which are believed to be traceable to no other source than water impurities and conditions arising from the fume effects.

ATMOSPHERIC EFFECTS OF THE FUMES.

Practically every witness introduced by complainant identifies and declares the exceedingly foul odor of the defendants' fumes. The entire atmosphere of the region is so charged with and contaminated by the noxious gases that not only is its inhalation rendered most uncomfortable by reason of its irritating effects, but most distressing because of its foul odors. It is not the sulphur dioxid alone which results in the foulness of the atmosphere, but its combination with copperous fumes and other gases, the whole fume body giving forth an odor disagreeable beyond description.

In the matter of sunlight, conditions have recently improved to a degree, but much room for improvement still remains. The fumes no longer continue to roll over the entire territory from the plants to the place of their absorption by the vegetation or purification by rain, but now sometimes travel for miles before enveloping the earth below. When they do descend, however, they are as dense and uncomfortable as ever, the fume odors being stronger than before; the only improvement being that the territory immediately adjacent to the plants no longer has the sunlight continually obscured as the primary fume discharge is condensed and spreads but little until it begins to fall.

An illustration of the density of the fumes at a considerable distance from the plant is afforded by the picture exhibits of Edwards and Jones, taken during the summer of 1906, one of which shows the fumes twenty miles from the plant so heavy that objects but a short distance away can not be discerned, and in which picture the dense fumes have the appearance of a lake rather than a fume cloud. The picture exhibits of Ralph I. Smith and Horace Fields also serve to give some conception of this form of the nuisance.

LACHES.

That laches could under no conditions apply to the right to relief from the injuries of defendants is respectfully urged. No prescriptive rights can be acquired to maintain a public nuisance or against a sovereign State. In addition, this nuisance is not stationary, but a continuing and growing nuisance, one which has within the last year increased about six hundred per cent., both in amount and territory subject thereto.

Regardless of all this, however, the uncontradicted testimony of about four thousand witnesses show the beginning of the fume injury in Georgia to be coincident with the beginning of operations by the Tennessee Copper Company and the increased operations and production by the Ducktown Sulphur,

Copper & Iron Company between five and six years ago. More than three years ago an investigation was ordered by Georgia, and immediately upon receipt of the report of the investigating committee and refusal of the defendants to cease committing the acts resulting in the damage, suit was filed to restrain the nuisance. This suit was dismissed upon representations by defendants and agreements to abate the nuisance. Instead of remedying conditions the defendants immediately began operations which vastly increased all injuries, and as soon as it became apparent that defendants would take no steps to abate or even tending to abate the nuisance, this suit was filed.

The facts of this record disclose that instead of complainant being guilty of laches a directly opposite condition exists—that defendants erected their plants and began their operations with full knowledge that the resultant injuries and nuisance would occur. In the very beginning they laid their plans to forestall any injunctions or judgment for injuries in favor of the landowners of the region, farmers and mountaineers without means to employ high-priced experts or to obtain the technical testimony necessary to secure relief. Immediately after commencing operations in 1901, at the very commencement of the injury, they put out their men to prepare evidence, with reference to "the extent of the injury, if any, being done by the sulphur fumes from the Ducktown copper plants" (Defendants' Original Record, pages 73, 74), and to discourage litigation in consequence thereof. Even without this admission, the knowledge of the necessary consequence of such operations would be imputed to the defendants, as it is not only a matter of common knowledge to copper producers, but to the public at large, that the incineration of sulphurous ores destroys vegetation in the ratio of the amount of sulphur consumed, unless said fumes are condensed or otherwise provided for.

THE TALL STACK OF THE TENNESSEE COPPER COMPANY.

One of the chief causes of the enormous increase of injury during the past spring and summer was the tall stack and enlarged plant of the Tennessee Copper Company, through the consequent increase in both amount and strength of the fumes produced. This tall stack and new furnaces were not built until after the litigation herein had been instituted, these additions to the defendant's works being completed about a year after service of notice to desist in the commission of the nuisance. Notwithstanding the service of such notice and subsequent suit herein, the new furnaces and tall stack were erected, being rushed to completion and placed in operation immediately prior to the hearing upon application for temporary restraining order the latter part of April, 1906.

The new furnaces were part of the general scheme for the enlargement of the works of the Tennessee Copper Company, for increasing the production and decreasing the producing price of copper (Complainant's Record, pages 100 to 104), determined upon immediately after the dismissal of the first suit in relation to the sulphur fumes (Complainant's Record, page 99). The tall stack was subsequently planned when it became apparent that the old and smaller chimney of the company was insufficient for the enlarged plant and that a new stack of such a character as that erected was necessary to afford proper draught for and permit the safe operation of the new works by defendant's employees. (Complainant's Record, pages 103, 104; also Defendant's Original Record, pages 127, 129, 142, 143.) This stack was planned and erected by the company for its own purposes and to meet its own needs and without suggestion, so far as complainant is aware, from any other source.

Complainant is quite willing to concede, if material in any sense to this case, that, in addition to affording a proper draught and increasing the efficiency of its works, it was the

hope of the Tennessee Copper Company that the new high stack might also minimize if not entirely remedy the damage being done. Unfortunately, however, no such result was realized and instead of becoming a remedy for the fume evil the tall stack became an agent for additional and terrific destruction as is shown by the testimony of United States Forester Patterson, Chemists Haywood and McCandless, foresters Mauney and Weller, Georgia's Commission, and more than two thousand inhabitants of the Georgia Ducktown region.

REMOVAL OF THE TENNESSEE COMPANY'S INCINERATING PLANT.

At the time the first suit involving the sulphurous fumes was filed the sulphur contents of the ore of the Tennessee Copper Company were burned off in open roast heaps, after which the remaining ore mass was taken to the smelters of the company at McCays for smelting and refining. The Tennessee Company then had three roast heap yards adjacent to its three mines. (Map, Complainant's Record, page 102. Admission of President Channing of the Tennessee Copper Company, Defendant's Original Record, page 142.)

Since the abandonment of these roast heaps the incinerating appliances of this defendant have been installed at the old smelter location at McCay's, a hundred yards or so from the Georgia line, where all incineration, roasting and smelting now occurs, and it is there the ore is freed of its sulphur contents. The denial of the allegation that there has been a change in the place of ore incineration since the first fume suit is not warranted under the record and the testimony of this defendant's officials that there has been no removal of the Tennessee Company's "roasting and reducing plant" is calculated to give an erroneous impression in this regard.

The only incineration of ore by the Tennessee Copper Company is now at McCays, at which place all sulphur contents of the ore is now freed and converted into sulphur dioxid, and

which location is several miles nearer Georgia than were the roast yards used for burning off the sulphur when the first suit concerning these fumes was filed. (Complainant's Record, pages 102, 232, 316, 337, 349.)

CONDENSATION OF SULPHUR DIOXID INTO SULPHURIC ACID.

The attitude of complainant throughout the entire litigation concerning the fume injuries, in both the case at bar and the first suit thereon, heretofore dismissed, has been such as to afford the defendants every consideration, to give every possible opportunity to permit the complainants themselves to cure the nuisance, rather than to seek to enforce a remedy under the mandate of a court decree.

It has been more than three years since Georgia first instituted proceedings after defendants' first refusal to abate the mischief they were causing. Complainant has neither desired nor sought to oppress or harrass the defendants, and its policy has been to permit delay and to suffer further injury in order that defendants might be afforded every chance to so improve, alter and operate their plants as not to injure their neighbors. If any criticism of complainant's policy is to be made it is that complainant has been too long-suffering, too liberal with defendants, and too considerate of their interests.

In the three years and more covering the fume litigation one defendant has done nothing, but continue to operate its plant in the same manner it was doing the day the first suit was filed. The other has removed its incinerating operations to a point immediately adjacent to the Georgia line, more than doubled its capacity, and made only such changes and improvements as were necessary to secure the highest possible copper production from its enlarged plant.

This is the situation disclosed by the record, the exposition of the policy of the defendants in contrast to the attitude of complainant, a policy adopted in the face of the fact that the

nuisance could have been remedied by the institution of proper appliances which would not have lessened the production of defendants' plants except during the period of their installation, and which, in the end, would have afforded an additional and commercially valuable product.

This ability to so abate the nuisance had not only scientifically demonstrated, but, prior to the institution of this suit, duly acknowledged by the president of one of the defendants, and by him as such president reiterated in communications to technical journals of the copper trade. In fact, all this in relation to the power to condense the fumes and eliminate the sulphur dioxid injuries had been judicially declared in the case of the United States *vs.* the Mountain Copper Company, in the United States District Court for the Northern district of California, a decision familiar to defendants.

And when complainant for the second time submitted the report of its committee showing the increased injuries from defendants' fumes and requested the defendants to abate the nuisance, the request was met by a refusal. The defendants preferred to operate their plants to capacity during the abnormally high copper market, regardless of the damage they might do, rather than delay operations long enough to install other appliances which might eliminate the nuisance.

Each of these facts counsel believe has been established beyond controversy. Prior to the first suit herein it was shown by the Bureau of Chemistry of the United States (Complainant's Record, page 17), that a complete remedy might he had under a proper condensation of the sulphur dioxid. It was further declared in the Mountain Copper Company case, and was by President Channing, of the Tennessee Copper Company, directly admitted some time in advance of the institution of this cause. (Complainant's Record, page 103.) It was set forth by technical copper journals (Complainant's Record, page 104), and is not now actually denied by the defendants.

That the results of this condensation is a commercially valuable product, consumed in infinitely larger quantities in Ten-

nessee and the adjoining States than the gross possible production by defendants, is demonstrated without contradiction or question by the record.

The sulphuric acid used throughout the Southern States is made by the condensation of sulphur dioxid obtained through the incineration of sulphur pyrites, the average cost of which is $8.60 per ton, and which pyrites produce sulphur dioxid ton for ton. (Complainant's Record, pages 111 to 119.) The condensed product, the sulphuric acid, has a value of $10.40 per ton f. o. b. Atlanta, the center of the sulphuric acid consumption in the State of Georgia. (Complainant's Record, page 135.)

The commercial uses of sulphuric acid are large and varied. A partial list of its uses is contained on pages 105 and 106 of Complainant's Record, more than fifty being there specified. Chief of the uses in the territory adjacent to Eastern Tennessee is in conjunction with phosphate rock, to produce acid phosphate, in refining oils, sugar and glucose, and in the manufacture of fertilizer, explosives and other acids.

The gross possible production at capacity by the Tennessee Copper Company, under its enlarged plant, is 532,170 tons of chemically pure sulphuric acid, or 851,206 tons of 50 per cent. or chamber acid per annum. (Complainant's Record, pages 136, 137.) The capacity of the Ducktown Sulphur, Copper and Iron Company is about one-sixth of that of the enlarged plant of the Tennessee Copper Company (3,000,000 as compared with 18,000,000 pounds copper production, Complainant's Record, page 101). Estimating the ratio of production between the defendants to be slightly over one to four, instead of one to six, the maximum production could reach to but about one million tons of 50 per cent. or commercial sulphuric acid per annum.

In conjunction with the phosphate rock alone produced in the States of Tennessee, South Carolina and Florida more than double the gross possible production of sulphuric acid by defendants is required. (Complainant's Record, pages 119, 120,

and also 111 to 119.) The record of the acid consumption in the refining of cottonseed and other oils and sugar and glucose is not available, but it is unquestionably very heavy. The sulphuric acid contents of fertilizer amounts to a little over two-fifths of the gross tonnage (Complainant's Record, pages 111 to 119), and in the States of Florida, Georgia, North and South Carolina, Alabama and Tennessee about enough fertilizer was consumed in 1905 to utilize the possible output of acid by defendants. (Complainant's Record, page 121.) The consumption of fertilizer throughout the South is rapidly increasing. In Georgia the increase has amounted to nearly fifteen hundred per cent. in thirty years, and there are now within the State 184 licensed fertilizer manufacturers and mixers, all of whom are, of course, consumers of sulphuric acid. (Complainant's Record, pages 122 to 128.) Great quantities of sulphuric acid are used in the manufacture of explosives (Complainant's Record, pages 109, 110, 111), and also in the manufacture of other acids. (Complainant's Record, pages 106, 107, 108.)

Counsel will not burden the court with further illustrations of the uses and consumption of sulphuric acid, their object being merely to show the amount required in some of the most important uses, which alone vastly exceed the possible supply which might be afforded by defendants' plants, and which demonstrate the commercial feasibility at defendants' plants of the condensation of the sulphur dioxid.

CONCLUSION.

While counsel do not believe that the findings of law in the case of Madison *vs.* Copper Companies, 111 Tenn. 338, heretofore relied upon by the defendants, sets forth the true law in the case of a public nuisance, even under statutes such as those of Tennessee, or that this decision would or could be followed by this Honorable Court, the conclusions of law reached by the Tennessee Supreme Court can, in no event, have any bearing upon the case at bar.

While, under the decision of the Madison case, it is true that no one, ten, hundred or, possibly, one thousand citizens of Georgia within the Ducktown region can measure dollar for dollar with the defendants in order to qualify for equitable relief and the enforcement of constitutional guarantees in the courts of Tennessee, still, the injured territory covered by complainant's bill, a bill which under the laws of Georgia could be filed only by the State, overshadows the interests of defendants. Already the harmful effects of the fumes have reached about fifteen hundred square miles of territory, a considerable majority of which is in Georgia. The testimony of the experts in this connection show the fume injuries to involve a horn or V-shaped region which widens rapidly as it extends into Georgia. Estimating the injured territory in Georgia at 1,000 square miles, or 640,000 acres, of farm and timber land, it would amount, at an average of but $5.00 per acre, to a sum in excess of three million dollars. The sum total of the threatened, direct damage by the destruction of forest and vegetation, the extent of the area which the fumes would immediately affect even under but a single additional summer of fume injuries, is difficult to estimate in view of the enormous increase of damage during the past year, but it would unquestionably be very large.

The consequent injury from the fumes outside of the Ducktown region are as yet but a matter of conjecture, for no means are now available for ascertaining the exact damage by erosion, floods and freshets and injury to water supply. In France, under erosion alone, from the destruction of forest in a territory about the size of that already affected by the fumes, it was found that the injury extended over two hundred miles from the source of the evil, the population within that radius being driven out and pauperized. (Complainant's Record, page 78.) The full effect of the forest destruction upon floods and water supply have not yet been felt nor fully ascertained. It is already apparent, however, that from all of these necessary consequences of the damage by defendants, if the fumes are to continue, or the vegetation is not renewed, the injury will be vastly greater than that occasioned by the mere destruction of forest, gardens and crops.

Another basis for the decision in the Madison case, distinguishing it from the case at bar, was the finding of fact that the plants of defendants could be operated in no other manner than that in vogue at Ducktown (open heap roasting) at the time the Madison case was filed. This was a wholly erroneous conclusion of fact, for before this decision was rendered a different process was in use, and it had also been demonstrated that the fumes could be condensed, a fact admitted by the president of one of the defendants.

In the present case, in all events, there can be no claim that no other mode of operation is possible, or even commercially feasible, for the record clearly discloses that by the institution of proper appliances and under proper operation of the plants not only can the nuisance be remedied, but an additional and commercially valuable product may be obtained.

In conclusion, counsel desires to repeat that at no time has there been any effort or desire on the part of the State of Georgia to oppress or inflict needless hardships upon the defendants. No attempt is even made to recover compensation for the heavy injury already wrought. All that is sought is to

preserve Georgia's territory and citizens from further and, as complainant believes, wholly needless injury by defendants, to prevent the complete pauperization of the inhabitants of the Ducktown region, and the destruction of their occupations and means of livelihood, to preserve the fertility and value of the outlying lands adjoining the zones of injury, and to protect the water supply of the State at large from further damage; in short, to force the defendants to desist from their operations, which produce the injury and the nuisance.

Respectfully submitted.

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